Chapter 1

THE POLITICS OF UNCONVENTIONAL OIL AND GAS AND THE CHALLENGE OF COMPLIANCE

Advances in technology vis-à-vis air and water quality are among the twentieth century's greatest achievements in terms of environmental management. The nation's air and water resources are generally cleaner, federal and state environmental agencies have developed new capacities, and energy is reliably delivered to millions of consumers. In fact, compared to the first half of the twentieth century, the United States has made great strides in safeguarding the environment and providing safe and clean energy (Klyza and Sousa 2013). It is within this landscape that the transition to unconventional oil and natural gas politics and management took place and continues to take place. Today, oil and gas production vis-à-vis fracking has helped ensure access to reliable heat and power for millions of Americans, it employs thousands, and it supports the American economy in myriad ways. Yet, it is also a heavy industrial activity that can seriously harm the environment and can lead to pernicious impacts on the public's well-being. Operating between these "goalposts" is a network of public and private sector actors who are producing, distributing, and consuming oil and gas in such a way that they satisfy multiple goals such as efficient production and environmental integrity. To accomplish these goals, local, state, and federal governments, as well as operators, engage in a set of activities known as compliance—in short, establishing performance standards and then designing enforcement systems that maintain a state of compliance.

Despite the many remarkable accomplishments of the twentieth century, the nation's regulators and the systems necessary to deliver energy are increasingly confronting a fleet of natural and man-made threats. At just the original point of extraction, for example, the new technologies of hydraulic fracturing and horizontal drilling have opened up new production. They have also required regulators to develop new testing protocols, new inspection processes and evaluative criteria, and administrative learning. Preexisting and increasing nonpoint sources of pollution have added new layers of technical and political complexity and have made it more difficult to isolate the source of contamination. Wildfires, storms, and other external shocks add yet another layer of challenges impacting oil and gas operators and regulators (Fisk 2017). Transporting fuels and waste products and safely closing a site add to the difficulties faced by regulators. These issues range from the labeling of trucks that are transporting wastes to disposing of fracking fluids, and they can add costly political and administrative challenges.

The lineage of today's fracking debate can be traced back to the first wells coming on line over a century ago. Since the nineteenth century, the American landscape has witnessed oil and natural gas operators drilling more than four million wells from California to Pennsylvania. In fact, fracturing, as an idea, is at least seventy-five years old. Early attempts at fracturing rocks and other underground formations, for example, began in the 1940s. Whereas the technologies have changed, operators have utilized fracking-related extraction processes in at least one million oil and natural gas wells. Unlike many of today's wells, many of these "historical" sites were barely noticed, caused little in terms of known surface disruptions for nearby residents, and were located in predominantly rural areas (American Petroleum Institute 2014). Hydraulic fracturing in the twenty-first century is much different. While the evolution of today's operations stretches back over sixty years, the specific technologies supporting it began to be widely deployed in the mid-2000s (Fisk 2017). This technology, coupled with a favorable policy environment, set the stage for the fracking boom. For shale gas, the boom began around 2005, with similar technologies making tight oil extraction commercially viable around 2007–2008.

Extant oil and gas operations involve multiple stages, actors, and processes. Operators receive multiple permits, are subject to planned and random inspections, drill both vertically (up to 10,000 feet) and horizontally (usually between 4,000 and 10,000 feet) and inject thousands of gallons of proprietary chemicals, water, and sand into underground formations (Dunn 2014). Once the site is prepared and fluids are injected, fracking begins, and hydrocarbons and other fluids flow up to the surface (Dunn 2014). These fluids must then be separated, and the hydrocarbons eventually enter the market while the wastes must be disposed of. Each state operates within its own set of rules, typically with specific standards contingent upon the resource to be extracted, enforcement practices, the location of wells, the governing jurisdiction, underground geology, and even the operator itself (Dunn 2014; Pless 2011).

A vigorous debate over fracking and the challenges of compliance followed. The debate, Fisk (2017) writes, has taken place across statehouses and in the nation's capital and involves a common set of issues that are simultaneously highly technical and salient, that likely elicit powerful symbols and emotions, and that impact millions of citizens. To this list, the compliance question adds complicated questions about responsiveness, trust in government, and regulatory legitimacy. Regulatory compliance cuts across each part of the production life cycle: locating and acquisition of mineral rights, site preparation, permits and drilling, fracturing, and postdrilling activities such as moving resources to the market. In other words, compliance is at the heart of the fracking debate.

The politics of unconventional oil and gas production (i.e., fracking) are well known. These debates, we argue, extend to practices and priorities governing inspections, the detection of violations, and the use of administrative tools to ensure compliance. Supporters argue that domestic oil and gas production is responsible for economic benefits, such as jobs, new tax revenues, and investment, as well as national security benefits, such as avoiding importing hydrocarbons from geopolitically uncertain regions and nations. At the subnational level (state and local governments), many of these "shale" benefits are place-specific and very much needed. The expanded production in these communities translates into new job growth (with well-paying industry jobs), lease revenues for mineral owners, additional tax revenues via new taxes and fees, and direct investment. For all Americans, supporters note that domestically sourced oil and gas via fracking produces abundant, reliable, and cheap energy that is needed to fuel vehicles, generate electricity, operate industrial facilities, and heat homes. Advocates add that oil and, to a lesser extent, gas may be exported, which can supply new international markets and lead to even greater economic growth. Opponents, on the other hand, argue that unregulated production harms air quality, fragments forests, and threatens ground and drinking water. Moreover, they contend that many of the economic benefits are overblown, temporary, and not enough to outweigh the risks and costs. They continue by suggesting that existing regulations and associated regulatory agencies often fail to adequately balance hydrocarbon production with the public's need for a clean, quality, and safe environment (Davis 2017; Fisk 2017).

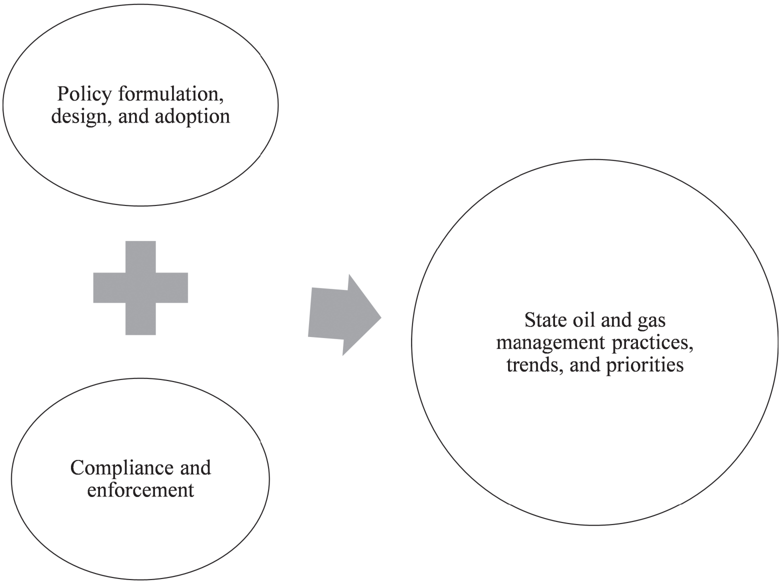

Figure 1.1. Understanding Oil and Gas Management

Whereas the debates are national in scale, the overall management of oil and gas is intergovernmental. The federal government generally oversees production on federal lands, distribution of resources via interstate pipelines, and overall grid reliability and security. In contrast, much of the day-to-day management (e.g., site preparation, permitting, extraction, and site cleanup of oil and gas resources) falls to the states (Fisk 2016; 2017). In fact, state governments have traditionally overseen the oil and gas industry and, as such, have developed the requisite expertise, protocols, and competencies to engage in a wide variety of compliance activities. Despite the states' prime role in oil and gas regulation, the context governing oil and gas production is intergovernmental. For example, the decisions made by federal regulators to approve a new pipeline, support additional drilling on federal lands, or regulate methane emissions are likely to create new compliance demands for state inspectors.

Despite the light but growing federal footprint, which is addressed primarily in chapter 3, we focus here on broad categories of state regulatory activity, as shown in figure 1.1 (Fisk, Good, and Nelson 2017). The first part refers to the formulation and design of applicable rules, policies, operating procedures, inspection schedules, testing protocols, and potential fine amounts. These, we suggest, are the guardrails and standards that operators must meet to remain in compliance. To date, lawmakers in more than thirty states have adopted wide-ranging site safety policies, information disclosure to citizens and state officials, and chemical information disclosure to healthcare professionals and local governments, and they have influenced siting locations, applicable taxes and fees, permitting standards and schedules, technical standards, intergovernmental relations, security, environmental impacts, and short- and long-term site remediation. These policy arenas have identified an array of social, economic, political, and site-specific factors that help to explain state variation, policy design, and even the degree to which environmental interests are balanced with extraction goals (Fisk, Good, and Nelson 2017). The second piece of this puzzle addresses how state regulators ensure compliance with such rules. This involves a range of factors including applicable policies, missions, politics, economics, budgets, staffing, technology, data that shape inspections, criteria of a violation, and administrative activities. Here, however, less research is available that seeks to explain the decisions of inspectors, the use of compliance tools, or why enforcement actions vary over time. This dynamic is reflected in figure 1.1.

As shown in figure 1.1, both pieces are critical to compliance and to the understanding of how states meet their oil and gas management goals. In other words, both rule formation and compliance are likely to remain hotly contested, as the impacted actors and institutions are often seeking or weighing significant economic and political rewards, serious public health and environmental risks, and additional responsibilities of state and local governments and administrators (Fisk, Park, and Mahafza 2017). The high stakes, as well as some of the governance challenges, are captured in these observations from stakeholders:

> John Tintera, Texas Railroad Commission (RRC) executive director, in reference to the RRC's well inspection process, noted, "No agency can have a police officer behind every stop sign. . . . We prioritize our inspections, and we respond to every complaint. In seeking compliance, we have many tools, one of which is to go to enforcement" (Soraghan 2011).
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> The secretary of Pennsylvania's Department of Environmental Protection, John Quigley, noted, "Our (DEP) inspectors go out with clipboards and carbonless paper . . . when folks from the industry use iPads—tap, tap, tap, upload your data, go on to the next well. . . . We're dealing with antiquated technology, we're drowning in paper" (Phillips 2016).
>
> Chris Sandoz, from the engineering division of the Louisiana Office of Conservation, stated that the agency expected "operators to have their wells in good shape whether we're there or not" (Soraghan 2011).

> Texas Sunset Advisory Commission director Ken Levine observed, in reference to oil and gas enforcement, "If you never get penalized for it, you're probably not going to stop speeding. . . . That's essentially what's happening in the field" (Soraghan 2011).

At the core of these quotes are normative concerns about compliance, the behavior of stakeholders, and how best to reach multiple goals. Clearly, for some stakeholders, the lack of robust oversight is problematic, especially as it relates to the industry's behavior—its willingness to take steps that would minimize air and water pollution and that would protect public health. Others note their expectations for the industry to be a strong and responsive partner, correctly observing that regulators cannot be everywhere at once. Finally, these passages also highlight the role of third parties and citizens relative to compliance. Citizens and those located closest to production sites are among the most likely to be impacted by operations, to feel the associated economic gains, and to witness surface-level disruptions such as spills. Their important role includes the ability to highlight problems such as leaks, to call in with complaints, and to communicate with regulators and elected officials. Each of these actors operates within the setting described in figure 1.1 and affects the politics and challenges of compliance.

Linking Compliance and Production

State governments face real and perceived risks and rewards of oil and gas production. Whether tangible or not, how stakeholders perceive, prioritize, and determine the costs and benefits of development matters a great deal when it comes to compliance. If state and local stakeholders experience direct and indirect benefits, trust in the sanguine economic forecasts, and believe that the risks are minimal, they are likely to support policies (in terms of both design and compliance) that impose minimal costs on the industry, that encourage production, and that utilize a small compliance footprint. Whereas, if the real and perceived risks are substantial, policy makers are more likely to support tighter controls, more inspections, and coercive actions designed to bring operators back into compliance. Thus, compliance does not exist in a political vacuum and must be considered with several interrelated pieces:

> The type of production or resource and its location

> The applicable slate of federal, state, and (if available) local regulations or policies and how violations are determined (i.e., what are the standards)

The distribution of costs and benefits (i.e., who is experiencing the risks and rewards of natural resource production and to what extent)

The agencies enforcing said rules (i.e., who is enforcing them and what are their abilities, capacities, and priorities)

The political, administrative, and economic environment and the preferences and characteristics of stakeholders (Fisk 2017)

Most operators seek to work within applicable regulatory frameworks and to be a "good neighbor." However, compliance operations are a necessary aspect of oil and gas management and involve inspections, identification of violations, and questions about how best to bring the operator back into a state of compliance. This is especially true during a well's productive phase. When violations are recorded, activists have seized upon them to push for changes in policy design, to increase the severity of penalties, to intensify compliance protocols (e.g., frequency of inspections and number of inspectors), and to question the legitimacy of administrative agencies—all of which may increase the operators' costs. As a result, even the number of available inspectors and agency budgets have become focal points for the broader political forces engaged in debates concerning oil and gas production. In short, compliance dynamics do not exist outside the debate over oil and gas production.

WHAT AND WHERE ARE OIL AND NATURAL GAS DEPOSITS AND WHY DOES LOCATION MATTER?

The type of resource matters. Oil and natural gas extracted from shale or unconventional deposits often include specific rules and standards that are different from oil and gas extracted from conventional sites. As such, we begin by briefly elucidating what oil and natural gas resources are and where they come from. Oil and natural gas are fossil fuels that formed millions of years ago as once-living materials decayed and were compressed at high temperatures and pressures. The type of natural gas and where it is "found" often determines its type and the specific extraction processes used by the industry (EIA 2018a).

Conventional natural gas settled into large cracks and spaces between layers of subsurface rocks.

Unconventional natural gas settled into tiny pores among shale, sandstone, and other sedimentary rock formations (also called shale gas or tight gas).

> Natural gas that settled with deposits of oil is often called associated natural gas.
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> Coalbed methane is natural gas that settled with coal deposits.
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> Wet natural gas is methane (gas) that is found with associated compounds such as ethane or butane.
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> Dry natural gas is just gas with no associated natural gas liquids.
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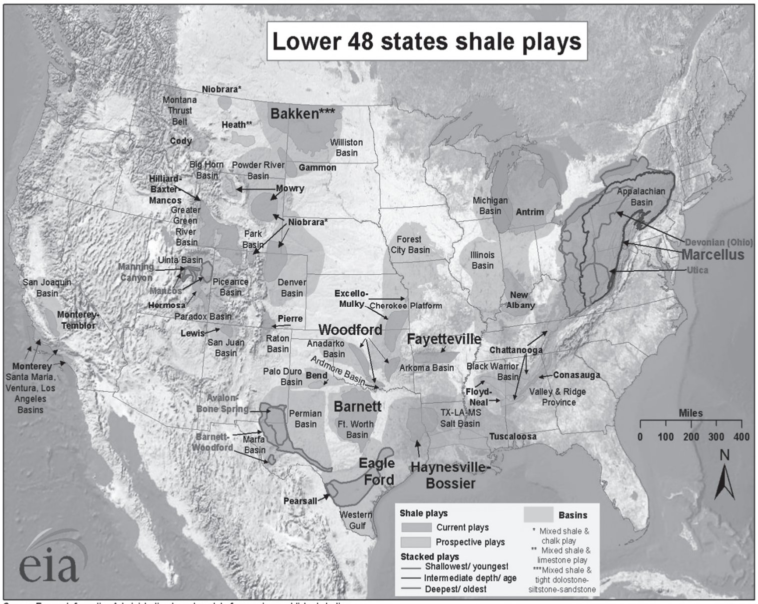
> Oil (or crude oil) may exist as a liquid in underground reservoirs, within sedimentary rock, or near the surface in tar (or oil) sands (EIA 2018a).

Oil and natural gas deposits are not uniformly distributed. Two-thirds of US natural gas production, for example, takes place in five states. In 2017, 23 percent took place in Texas, 20 percent in Pennsylvania, 8 percent in Oklahoma, 8 percent in Louisiana, and 6 percent in Ohio (EIA 2018b). Major deposits are shown in figure 1.2. These states stand out for several reasons. First, elected officials and state governments are more likely to experience the costs and benefits of oil and gas development and to possess experience in promulgating and enforcing state oil and gas policies. Second, like their respective state government, citizens in these jurisdictions (especially those located near production) are more likely to witness and participate in development activities such as receiving lease revenues, working in the industry, and experiencing spills and other contamination. In other words, compared to nonproducing states, extraction states are simultaneously more likely to encounter the risks from production (e.g., spills or contamination) and the benefits from oil and gas (e.g., tax cuts, job creation, and economic growth). Despite sharing a similar set of costs and benefits, the aforementioned states do differ in other ways, including state politics and ideology, their overall production levels, their region, and the extent to which they are economically dependent on oil and natural gas extraction (Fisk 2017).

> Texas and Oklahoma are traditionally conservative states with approximately 6 million and 1.2 million residents living within one mile of an oil and gas state. Both generate a significant amount of their state GDP from natural resource extraction.
>
> Ohio and Pennsylvania are traditionally swing states with 2.6 million and nearly 2 million residents, respectively, living within one mile of an oil and gas state. Each state produces a significantly smaller percentage of its state GDP from natural resource extraction (Gold 2014; Gold and McGinty 2013; Fisk 2017).



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

Figure 1.2. Shale Plays in the Lower 48

We also provide data on proven reserves, as identified in table 1.1. According to the Energy Information Administration, reserves' "estimates change from year to year as new discoveries are made, as existing fields are thoroughly appraised, as existing reserves are produced, as prices and costs change, and as technologies evolve" (EIA 2021; n.d.). They are related to market and regulatory conditions that affect the cost of doing business in a particular location. If a compliance regime, for example, imposes higher costs on industry, its proven reserves are likely to shrink. Or, if oil and gas prices decline (e.g., due to weak demand, oversupply, or competition from renewables), it is likely that firm profitability will fall as well, meaning that reserves are also likely to shrink (EIA 2021; n.d.).

We return to the importance of well type. Prior to 2005, operators primarily extracted resources at conventional sites. This limitation was removed around 2005–2006, as operators developed the tools necessary to extract unconventional oil and natural gas. Today, extraction via hydraulic fracturing and horizontal drilling is largely driving increases in domestic production (Warner and Shapiro 2013). For example, in 2012, operators extracted nearly 30 million cubic feet (MMcf) from over 500,000 wells. These numbers are continuing their upward trend as of 2017–2018 and represent significant leaps from their pre-fracking oil and gas production levels, as shown in figures 1.3 and 1.4.

Table 1.1. Reserves (in trillion cubic feet)

	Proved reserves	**Extensions and discoveries**	**Revisions**	**Production**	**Proved reserves**
Source of gas	Year-End 2015	2016	2016	2016	Year-end 2016
Coalbed methane	12.5	0.0	–1.0	–1.0	10.6
Shale	175.6	32.3	19.0	–17.0	209.8
Conventional & Tight					
Lower 48 onshore	123.6	5.8	–9.5	–9.5	110.3
Lower 48 offshore	8.0	0.2	0.2	–1.3	7.1
Alaska	4.6	0.1	–1.1	–0.3	3.3
Total	324.3	38.4	7.6	–29.2	341.1

Source: EIA 2017a

Both figures 1.3 and 1.4 capture the increase in overall US production. Of note is that the boom for natural gas started slightly earlier than oil. However, extraction for both resources was increasing by 2008–2009, meaning that the context surrounding inspections, identifying violations, and deciding administrative actions following a violation was dramatically different by 2008 compared to the days before fracking.

THE PRODUCTION PROCESS

Oil and gas management and compliance begin prior to actual drilling. State regulators determine the information required on a drilling application or permit, any best management practices to be implemented, the cost (if any) of surety bonds, predrilling requirements, and other analyses that must be performed prior to drilling and after completion. Once the site is prepared and ready for drilling, additional rules may include the establishment of specific inspection schedules, performance standards, various permits, construction standards, production quotas, and the availability of specific administrative and punitive actions to ensure compliance. Additionally, administrative rules also govern the number and frequency of inspections, specific aspects to be inspected during a site visit, details of when and how reinspections may take place, actions available to inspectors and oversight agencies, financial penalties that may be issued, and standards operators must meet. If a violation is detected, state rules then shape the administra-

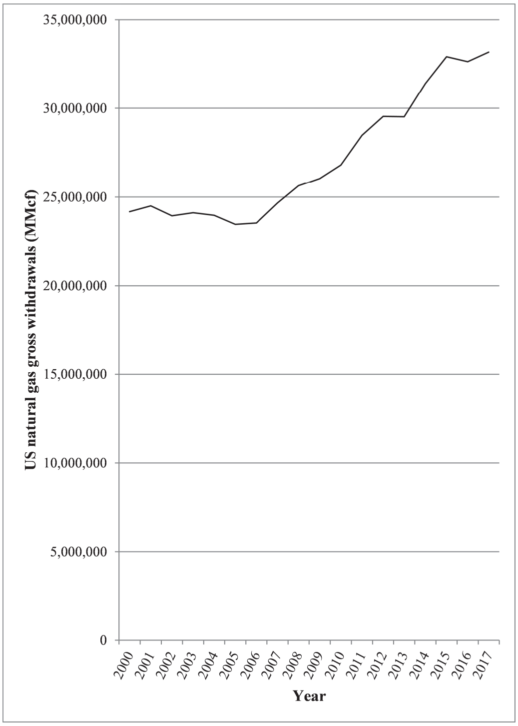


Figure 1.3. US Natural Gas Production

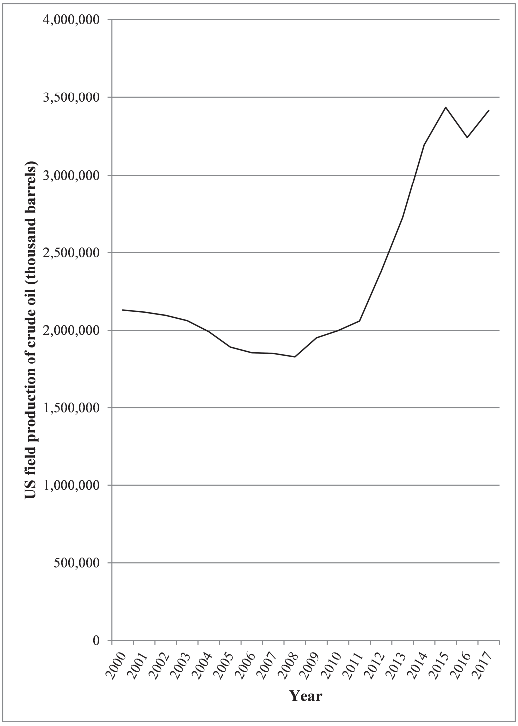


Figure 1.4. US Oil Production

tive options available to a regulator or inspector to encourage or require the operator to return to a state of compliance. More specific steps, mainly from an operator perspective, are presented in table 1.2.

Compliance is inherent to the various "steps" identified in table 1.2, as there are performance standards and testing protocols associated with each supporting activity. The various stages presented in table 1.2 also provide stakeholders with opportunities to further support or challenge the status quo. In other words, those seeking to support extraction may utilize compliance activities in a way that supports production. Moreover, the various stages also mean that compliance is likely to involve an array of agencies, stakeholders, and levels of government (Fisk 2017). See King (2012) for a comprehensive resource on the technical aspects of unconventional fuel production. The presence of multiple stages also forces stakeholders to engage with one another so that they may fully address questions of compliance such as the following:

1. What learning is required?
2. Are existing testing and standards adequate?
3. What data needs are there?
4. Is there adequate organizational capacity?
5. Is pinpointing causality possible?

In this way, compliance may invite an antagonistic relationship, but it also creates opportunities to collaborate, find balance among competing goals, innovate, and meet citizens' needs.

THE SCOPE AND CHALLENGES OF COMPLIANCE

Federal policy makers have few formal powers when it comes to state compliance outcomes or processes. Federal policies like the Energy Policy Act of 2005 have reduced the federal role relative to compliance even more. In other words, oil and gas infrastructure and actors (not including interstate pipelines and facilities on federal lands) are much more under the auspices of state regulators than those at the federal level. Oil and gas researchers have largely followed suit and have identified an array of factors that make the politics of oil and gas management a minefield for stakeholders (Fisk 2017). Overzealous enforcement may stymie growth and industry innovation, harm industry's competitiveness and raise its costs, and lead to antagonistic relationships between regulators and regulated firms. These practices, in turn, may mean that production goals, enshrined in state laws, are not met. Conversely, lax enforcement may threaten environmental health and public safety, may contribute to long-term site damage, and may allow operators to create a variety of environmental externalities. In this scenario, state environmental priorities, also ensconced in state law, are not satisfied.

Table 1.2. Common Stages in Oil and Gas Management

Stage	Common activities
Exploration	Operators locate and map potential resources. Operators negotiate and secure lease and any necessary contract with landowners or property owners. Acquire necessary permits from federal, state, or local governments. Post financial sureties or bonds. Conduct any required predrilling testing.
Site preparation	Prepare the well pad (the site that will contain multiple wells)—this includes clearing site vegetation and building roads so that vehicles and other infrastructure may be brought to the site. Transport requisite equipment and infrastructure—this includes tanks, water and blender pumps, monitoring equipment, and chemicals. If necessary, prepare a pit for storage of water, drilling fluids, and/or rocks generated from drilling and other site preparation. If necessary—build transport lines.
Well construction and drilling	Drill a hole (called a wellbore) into the earth—this can involve both vertical and horizontal wellbores. Typically operators drill vertically first and then turn the drill bit horizontally. Insert casing and cement into the well bore, which involves metal piping intended to prevent cross-contamination and can be secured via cement. Drilling fluid or mud is injected. Operators install a well blowout preventer to control release of oil or gas. Install venting and/or flaring as necessary to relieve internal pressures.
Hydraulic fracturing	Operators will run a series of tests for well integrity, equipment pressure, rock stress, and other factors prior to fracking. This will involve a site-specific blend of water, sand, and proprietary chemicals. Operators inject fracking fluids at high pressures to fracture or pulverize the subsurface formation. Operators reduce pressure to allow oil and gas to flow to the surface. Some of the fracking fluid will return to the surface; this is known as flowback. Naturally occurring water may also return to the surface; this is known as produced water. Hydrocarbons are moved to storage via gathering lines and other pipelines. Fracking is currently used in approximately 43–50% of domestic oil production and nearly 70% of natural gas production. In some states these numbers are higher.

Sources: Reproduced from Fisk 2017 with minor editing for style and clarity; Intermountain Oil and Gas BMP Project, n.d.

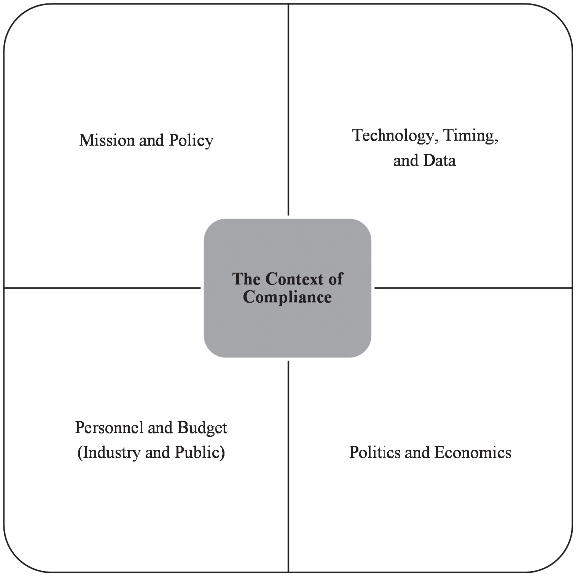


Figure 1.5. The Context of Oil and Gas Compliance

In either case, compliance is the common denominator and involves a set of administrative outputs related to inspections, violations, and administrative actions. These outputs are shaped by political support, available technology, knowledge, use of data, the clarity of applicable rules, and the capacity of state agencies and operators to enforce such rules, among other factors. These dimensions are further organized into four broad categories, as shown in figure 1.5, which we describe as an interactive context of compliance.

Mission and Policy

State oil and gas agencies respond to and implement a variety of goals. In Colorado, for example, state lawmakers charged the state's Oil and Gas Conservation Commission (COGCC) with four primary goals:

1. The efficient exploration and production of oil and gas resources in a manner consistent with the protection of public health, safety and welfare;
2. The prevention of waste;
3. The protection of mineral owners' correlative rights;
4. The prevention and mitigation of adverse environmental impacts (COGCC 2018).

The mission of the Pennsylvania Department of Environmental Protection (DEP) is similar: "Oil and Gas Management is responsible for the statewide oil and gas conservation and environmental programs to facilitate the safe exploration, development, and recovery of Pennsylvania's oil and gas reservoirs in a manner that will protect the commonwealth's natural resources and the environment" (DEP 2019b). The presence of these goals, according to researchers, shapes how state oil and gas agencies and elected officials prioritize their tasks, allocate financial, technical, and human resources, promulgate rules, and ensure compliance (Davis 2012; Fisk 2017).

Davis (2012) explains that on one hand, state oil and gas agencies are required (via state oil and gas laws) to facilitate efficient hydrocarbon production. This, in turn, may lead agency leaders, staff, and political principals to advocate or support more relaxed forms of enforcement such as supporting less coercive corrective actions and penalties. On the other hand, inspectors are expected to protect health and environment (and respect private property), which may contribute to greater administrative and political support for aggressive inspection schedules, more rigorous and frequent inspections, and more coercive actions, such as administrative orders or the assessment of financial penalties.

Technology, Timing, and Data

Compliance challenges are an amalgam of historical decisions and practices. They are also a function of new technology (and learning curves), demands, constraints, and decisions. In fact, today's inspectors may visit facilities that stretch back to the nineteenth century, when oil and gas wells first dotted the American landscape (Fisk 2017). Many of these older wells complicate compliance as they still demand regulators' time and attention and are not necessarily well mapped. They can be abandoned, meaning they do not have a current owner (that is still in business), or they have not produced oil or gas in quite some time, and some are in serious disrepair. Finally, they were built according to nineteenth- or early twentieth-century construction standards or utilized differing technology (American Petroleum Institute 2014). Fracturing practices in the 1960s are illustrative. During the 1960s operators, along with supportive federal agencies, began to fracture underground formations with nuclear devices. In 1967, for example, the collaborative effort that included federal scientists and the natural gas industry detonated a twenty-nine-kiloton nuclear device underground in rural New Mexico with the hope of fracturing subsurface formations. Through 1973, there were more than two dozen sites in which nuclear fracking had been the primary means of extraction (American Oil and Gas Historical Society, n.d.). While this particular methodology is no longer used, compliance involves oil and gas wells that were constructed during this period.

By 2005–2006, drilling processes and extraction technology had advanced enough to open up large swaths of previously unrecoverable oil and gas. These developments, as well as favorable market signals, helped launch the twenty-first century's shale oil and gas boom. By 2018, the fracking boom had spread to more than twenty states, leading to the construction of thousands of active and producing wells and consuming thousands of acres. Production by way of fracking continues to employ hundreds of thousands of workers and generates billions in revenues for state and local governments. It has even received bipartisan support, but extant research has shown Democrats to be more supportive of oversight (Davis and Fisk 2014). Thus, from a "numbers perspective," the compliance and management challenges facing oil and gas regulators are particularly daunting (American Geosciences Institute 2018). Other pertinent facts about the compliance workload include the following:

> Since 1859, operators have drilled approximately 3.7 million wells in the US.
>
> In 2018 the Environmental Protection Agency estimated that the number of abandoned and/or inactive wells (onshore) ranges from 2.3 million to nearly 3 million (EPA 2018).
>
> In 2017 there were around 1 million active oil and gas wells in the United States.
>
> Operators utilize unconventional production practices in approximately 95 percent of all producing wells (American Petroleum Institute 2014).

State oil and gas personnel face additional bureaucratic and technical challenges that shape enforcement and compliance. In some states, regulatory programs governing conventional oil and gas were established long before hydraulic fracturing or horizontal drilling. In some cases, this has meant that rule makers and inspectors attempted to apply "conventional" rules and tests for contaminants to unconventional operations, which, according to advocates, were not always sufficient or adequate (Davis 2012). Enforcement and compliance efforts may also be complicated by a lack of predrilling data, external events, or data at large. This can be especially problematic when it comes to assessing financial penalties to operators, who often have deeper pockets than state oil and gas agencies. If, for example, state regulators cannot ascertain or acquire data that speaks to environmental conditions prior to development (commonly referred to as baseline data), it is difficult to evaluate whether suspected contamination is linked to existing (or historical) hydrocarbon production, if it occurred naturally, or if it was associated with some other factor, and then to assess a financial penalty (Fisk 2017).

The type of well, stage of production, age, and productivity levels also shape how and when inspections and other compliance activities take place. Ohio Oil and Gas Association president Tom Stewart notes, "Older wells and low-producing wells don't need as much attention from inspectors. . . . In Ohio, the regulatory agency's time is better spent looking at how a well's being drilled in the front year of a well's life." Stewart then compared Ohio's oil and gas needs to those in Alaska and suggested, "In Alaska, for example, wells draw from massive reservoirs of gas and oil. . . . There, a single well might be a higher priority" (Gilmer 2012). Gaye Greever McElwain from the Texas Railroad Commission added that "inspections are scheduled for oil and gas leases, not individual wells. Gas leases hold one well each, but oil leases can hold many" (Gilmer 2012). In Pennsylvania, inspectors prioritize sites in which there is active drilling and fracturing in shale formations over older or idle wells.

As Fisk (2017) notes, the most productive phase of a well's life is often within its first years of production. During construction, as well as during this highly productive phase, the site is likely to have more activity and staff present (Jackson et al. 2014; 2011). However, as production dwindles, activity at the site winds down. The well's potential impact on public health and the environment, however, can last decades even with the site still subject to compliance. Several factors complicate compliance at this stage:

1. Many older, abandoned, or orphaned wells were drilled before the fracking-fueled boom and predate modern mapping and safety technologies but are still subject to inspections and administrative actions.
2. Many older, abandoned, or orphaned wells are not as prioritized for compliance as active sites.
3. Many older (and less productive) wells are sold by the initial operator to small producers with fewer resources and staff designed to interface with compliance staff.
4. Newer wells have been added to many states' inventory and they need to be inspected, sometimes without requisite staff.

Each of these creates new compliance demands, often without additional resources.

There are also significant safety and environmental challenges related to older, often unplugged, wells. They can, for example, leak methane and other toxic fluids and gases into nearby structures or water resources. This is particularly true for older wells, which can create a fire or explosion hazard due to the explosive gases released. The combination of the industry's growth since 2006 and its financial losses in 2020 have increased the potential liabilities of orphaned and idled wells.

Challenges associated with the COVID-19 pandemic further complicated compliance. First, domestic onshore oil and gas production experienced a precipitous decline, which has since rebounded but, at the time, contributed to temporary job losses, declines in tax revenues, closed production and facilities, and industry bankruptcies. These stressors are stacked on top of two million previously idled and possibly orphaned oil and gas wells that date back decades. Because there is no "owner" for these wells, the financial implications for state regulators are significant. A recent study of thirteen states, for example, estimated over 635,000 inactive wells. Of these, researchers concluded that more than 10 percent of those wells were improperly abandoned and closed. Specific costs depend on the well, its depth, and other factors but can easily exceed $100,000 (Ho et al. 2016).

Nelson and Fisk (2021) observed that producing states utilize an array of financial instruments to mitigate the financial risks related to well plugging and to even help fund state agencies. They note that the use and adequacy of such tools varies across the states, but they typically include some combination of the following:

A bond or financial surety (which can cover a single well or all wells within the state)

Severance taxes and fees associated with oil and gas production

Insurance

However, many orphaned wells were installed prior to the implementation of any of the above financial tools, leaving the state as the most likely financially responsible party. These place new fiscal demands on state administrative agencies, many of which are already underfunded (Nelson and Fisk 2021).

Personnel and Budget

State oil and gas regulatory agencies exist in an environment that is bureaucratic and competitive. For the former, state oil and gas programs and functions are assigned to specialized organizational units, which are likely to exist within a broader organization, such as natural resources or public health and the environment. They are then overseen and coordinated within a vertical hierarchy that seeks to serve the interests and goals of the parent organization. For the latter, agencies must also compete for budgetary and human resources within their "home" agency, with other departments, and with other legislative priorities. Underfunding or understaffing may have particularly harmful impacts vis-à-vis compliance. The lack of resources may delay inspections, limit the frequency of inspections, delay purchases or new hires, force staff to rely on outdated tests, and create high workloads for oil

Table 1.3. Oil and Gas Extraction Gross Economic Output (in billions of dollars)

Year	Output
2000	143
2001	142.3
2002	116.7
2003	166
2004	191
2005	249.3
2006	257.4
2007	276.9
2008	388.4
2009	227.6
2010	304.7
2011	372.9
2012	362.7
2013	426.4
2014	474.9
2015	269.6
2016	230.5
2017	304.7

Source: BEA 2018, reformatted for this book

and gas staff. More directly, budgetary resources can impact an agency's ability to recruit new inspectors or to retain experienced inspectors and other personnel that participate in the compliance process (Gilmer 2012). In 2018, for example, the Colorado Oil and Gas Conservation Commission reported that it nearly ran out of money and at one point reported a $5.6 million shortfall, even with new wells in the state. Todd Hartman of the COGCC explained that the agency's budget issues were caused by several factors, including the following: "Severance taxes have come in low, commodities prices have been lower than in the recent past and that's affected the amount of severance tax . . . and then a court ruling allowed operators to deduct more of their expenses before they pay that severance tax" (Kovaleski 2018).

Politics and Economics

Politics and economics are never "far" from state oil and gas agencies and regulators. In this sense, regulators face political and economic pressures related to consumers, the industry, elected officials, and state and national economic trends. In some states, researchers have observed that state oil and gas regulators and political leaders are inclined to work collaboratively with the industry to secure many of the economic benefits associated with expanded production. This may include industry-friendly rules, inspection schedules, and enforcement practices and penalties. Other states and leaders are more skeptical of oil and gas production and have supported policies that protect the environment and limit health risks (Davis 2012). These dynamics may be dramatically reshaped and reprioritized during focusing events and other disasters.

Supporters of domestic oil and gas argue that production yields a long list of economic, political, and financial benefits, which may depress demands for rigorous oil and gas enforcement efforts, as these may increase costs to industry and, in turn, consumers). They explain that expanded oil and gas extraction creates economic value, as shown in table 1.3.

As table 1.3 notes, across the United States, oil and gas output generates billions, with peaks between 2011 and 2014 and a decline beginning in 2015. Economic output largely follows the deployment of horizontal drilling as well as the use of hydraulic fracturing, albeit with a slight delay. The influx of fracking dollars enabled policy makers to fund politically popular efforts such as tax cuts, new infrastructure investment, lower energy costs, and increases in education spending (Fisk 2017).

The industry also employs thousands in well-paying jobs, often in communities that are still recovering from the recent economic recession (Fisk 2017). Second, production sends millions in revenues, taxes, royalties, and fees to government budgets and private citizens (Davis 2012; Fisk 2017). Third, millions of Americans directly rely on natural gas (as a baseload generating fuel) and oil (for transportation), meaning that because of domestic production, consumers have a secure and reliable source of electrical generation and fuel. Fourth, hydrocarbons are used in a variety of industrial and commercial applications, goods, and services (American Gas Association 2019).

Increased domestic oil and gas has contributed to a variety of substantial consumer benefits and savings as well (Fisk 2017). First, oil and gas wells and pipelines are already a common sight in many American cities and towns. As such, when compared with other energy types, oil and gas production requires fewer large-scale capital-intensive projects. Second, both are domestically sourced, meaning that consumers avoid relying on hydrocarbons from geopolitically unstable regions, which permits producers and consumers to enjoy greater levels of price stability and to engage in long-term natural resource planning. Third, advances in drilling technology have reduced operator costs. As a result, in many states and localities, end users

Table 1.4. Gas Prices (per thousand cubic feet)

Date	US natural gas well-head price ($)	US price of natural gas delivered to residential consumers ($)	US price of natural gas sold to commercial consumers ($)	US natural gas industrial price ($)	US natural gas electric power price ($)
2000	3.68	7.76	6.59	4.45	4.38
2001	4	9.63	8.43	5.24	4.61
2002	2.95	7.89	6.63	4.02	3.68
2003	4.88	9.63	8.4	5.89	5.57
2004	5.46	10.75	9.43	6.53	6.11
2005	7.33	12.7	11.34	8.56	8.47
2006	6.39	13.73	12	7.87	7.11
2007	6.25	13.08	11.34	7.68	7.31
2008	7.97	13.89	12.23	9.65	9.26
2009	3.67	12.14	10.06	5.33	4.93
2010	4.48	11.39	9.47	5.49	5.27
2011	3.95	11.03	8.91	5.13	4.89
2012	2.66	10.65	8.1	3.88	3.54
2013		10.32	8.08	4.64	4.49
2014		10.97	8.9	5.62	5.19
2015		10.38	7.91	3.93	3.38
2016		10.05	7.28	3.52	2.99
2017		10.98	7.89	4.14	3.52

Source: EIA 2018e; EIA 2018i, reformatted for this book

and elected officials are enjoying a fracking-fueled dividend through reduced energy prices and, in some cases, are unlikely to support policies and practices that may lead to increases in end-user prices, as shown in tables 1.4 and 1.5. Of note, at the beginning of the oil and gas boom in 2006–2007, electrical prices were over $6 per TCF (thousand cubic feet). In 2017 prices were slightly above $3.50 per TCF. Consumers have largely experienced declines in natural gas prices since 2006.

As tables 1.4 and 1.5 show, the rapid rise of onshore domestic oil and gas production has contributed to consumer savings. Between 2008 and 2012, for example, the price of gas delivered to residential customers declined by

Table 1.5. Electrical Prices

Average Cost of Electrical Generation for Natural Gas (indexed to Jan. 2008 as value)	
Month	**Cost ($)**
Jan. 2008	0
July 2008	3.43
Jan. 2009	–1.84
July 2009	–3.96
Jan. 2010	–1.53
July 2010	–3.09
Jan. 2011	–2.89
July 2011	–3.31
Jan. 2012	–4.62
July 2012	–4.88
Jan. 2013	–3.9
July 2013	–4.08
Jan. 2014	–1.19
July 2014	–3.82
Jan. 2015	–4.16
July 2015	–5.17
Jan. 2016	–5.28
July 2016	–5.32
Jan. 2017	–4.14
July 2017	–5.07
Jan. 2018	–3.16
July 2018	–5.05
Jan. 2019	–4.26
July 2019	–5.76
Jan. 2020	–5.68
July 2020	–6.27

Source: EIA 2022, reformatted for this book

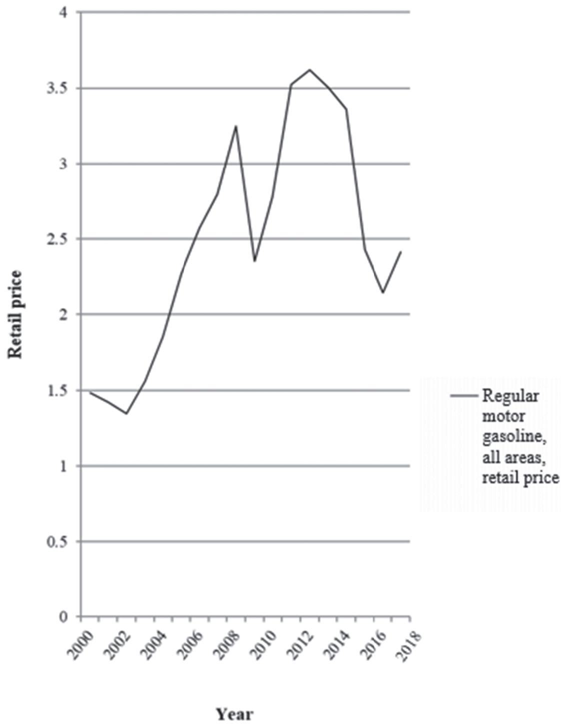


Figure 1.6. Retail Gasoline Prices

over $3, with industrial users seeing a much larger decrease. We note the political peril that an elected official may find him or herself in, should he or she seek or publicly support enforcement practices that raise industry costs, as these costs are likely to be passed on to consumers (Davis 2012).

Recently, researchers have quantified the overall savings to consumers brought about by unconventional oil and gas production. Dews (2015) concluded the following:

> Gas-consuming households across the United States have saved approximately $200 annually on their gas bills—although there is regional variation.
>
> Consumers in Arkansas, Louisiana, Oklahoma, and Texas received approximately $432 per person in savings.
>
> Consumers in Illinois, Indiana, Michigan, Ohio, and Wisconsin received approximately $259 per person in savings.

Table 1.6. Revenue Options

Tool	Explanation
Severance taxes	Severance taxes are assessed when the resource is "severed" from the ground. Severance tax rates and amount vary and are typically based on factors such as volume extracted, price (current or previous year), number of wells, value of the oil or gas, etc.
Impact fees	Impact fees are typically charged to cover the costs of development such as damages to roads and other infrastructure, etc.
Sales taxes	Sales taxes are collected at the point of sale and can be charged on purchases for oil and gas equipment and through up and downstream sales, subject to exemptions. Sales taxes are also impacted as the industry's workforce grows and declines and as oil and gas workers purchase goods and services.
Property taxes	Property taxes are levied on property or properties owned by the industry both directly and indirectly as its employees purchase and acquire property, subject to exemptions.
Administrative fees	These fees help cover the costs of development and the applicable state or local regulatory agency as it processes permit applications, etc.
Lease payments and royalties	These payments are remitted to the owner of the land or resource.
In-kind donations	Donations
Fines	These fees are charged to an operator if the state assesses a penalty.

Sources: Reproduced from Fisk 2017 with minor editing for style and clarity; Minor 2014; Raimi and Newell 2014

> Consumers in California, Oregon, and Washington received approximately $181 per person in savings.

Drivers have also benefited from increased oil production made possible via fracking, as shown in figure 1.6 (EIA 2019). Work supported by the American Petroleum Institute attributed declines in the cost of gasoline to hydraulic fracturing, estimating that fracking decreased per-barrel oil prices by between $12 and $40 in 2013, freeing up dollars for citizens to spend elsewhere (ICF International Associates 2014).

Table 1.7. Fracking and Funds

State	Year	Description
Alaska	2013	Changed tax rate to 35% of the production value of oil and gas
Colorado	2014	Allocated severance tax operational fund revenue to the wildfire preparedness fund
Colorado	2014	Transferred severance tax perpetual base fund to water conservation board construction fund
Illinois	2013	Established Illinois severance tax
North Dakota	2013	Allocated portion of production tax revenues to newly created outdoor heritage fund
Pennsylvania	2012	Created Pennsylvania's impact fee on oil or gas wells produced within the state
West Virginia	2014	Created West Virginia Future Fund and allocated 3% of the severance tax revenue to fund

Source: Reproduced from Fisk 2017 with minor editing for style and clarity

Revenues

One of the prime drivers for oil and gas supporters is the prospect of new and additional revenues. Researchers have noted that this potential has contributed to policy makers seeking industry-supported policies (Davis 2012). It can also shape the context of compliance and priorities of elected officials. Oil and gas revenues come in a variety of "shapes," "sizes," and "types," and are summarized in table 1.6.

Individual state policies often direct where these monies flow and how they may be used. Severance taxes, for example, are largely collected at the state level and may be redistributed to substate units of government, specific state agencies, or the support of specific funds or priorities. For example, since 2013, states have utilized or sought to utilize severance tax or impact fee dollars to cover politically popular tax cuts and to support other domestic priorities such as education, transportation projects, and public safety (Fisk 2017). Oil and gas property taxes, by comparison, are more likely to be collected by substate units of government and have yet to engender the same type of political contestation as impact fees or severance taxes. Finally, administrative fees, including drilling permits, are most likely to be collected directly by the regulatory agency and are often used to fund agency operations. Within this category of funding, the source varies by state; that is, some collect fees with the issuance of a drilling permit, whereas others may collect at different stages of the production process. In short, states use industry-generated or related revenues to fund a variety of governmental ser-

Table 1.8. Revenue Sources

State	Dedicated revenue sources	Allocation formula
Wyoming	Amount capped at 8/10 of a million ($0.0008) of market value	Revenues credited to state's Oil and Gas Conservation Commission
Ohio	The state collects: $0.025 per MCF of natural gas $0.10 per barrel of oil	Revenues are divided between two funds: 10% to the Geological Mapping Fund 90% to the Gas Well Fund
Texas	Severance tax on natural gas (7.5% of market value) Severance tax on oil (4.6% of market value) Various tax incentives and exemptions	Revenues are divided as follows: 0.5% of revenues cover enforcement Remaining revenues: 25% to the Foundation School Fund 75% to the state's general fund
Pennsylvania	Impact fee (changes annually)	Earmarks are first distributed to multiple state agencies. After earmarks: 60% of revenues are distributed to impacted counties and cities. 40% of revenues are deposited in the Marcellus Legacy Fund for statewide programs.

Source: Pless 2012b

vices and priorities beyond covering the costs of the applicable regulatory agency (Fisk 2017; Raimi and Newell 2014; Raimi 2017).

As shown in table 1.7, state lawmakers have sought revisions in state tax law as well as the creation of new revenues during the fracking boom. Examples include the creation of "rainy day" accounts and legacy funds to address costs associated with long-term site remediation and other environmental challenges (Davis 2012; Fisk 2017; Warner and Shapiro 2013). In other cases, such as Illinois and Pennsylvania, state lawmakers have created entirely new revenue streams. More specific examples from 2012 to 2014 are cited in table 1.7.

As mentioned above, states differ in how they collect and assess taxes and fees relative to oil and gas. These differences matter, as they can be used to fund regulatory agencies and schools, support tax cuts, and cover the costs associated with development, as shown in table 1.8. These fees, however, also have the potential to increase the costs of doing business within the state,

Table 1.9. Selected States and Severance Tax—2013

	Total taxes ($, in thousands)	Severance taxes ($, in thousands, including coal and other minerals)	Severance tax proportion of total taxes
Alaska	5,132,811	4,016,966	78.26%
Louisiana	9,223,829	834,116	9.04%
Montana	2,644,610	282,356	10.68%
Nevada	7,026,626	290,448	4.13%
New Mexico	5,201,576	713,998	13.73%
North Dakota	5,298,770	2,457,530	46.38%
Oklahoma	8,892,503	515,981	5.80%
Texas	51,714,295	4,647,848	8.99%
West Virginia	5,378,122	608,371	11.31%
Wyoming	2,186,054	867,933	39.70%
Colorado	11,245,662	147,732	1.31%

Sources: US Census 2014; 2013; reproduced from Fisk 2017 with minor editing for style and clarity

which can limit the firm's ability to generate a profit, disrupt the efficient extraction of resources, and preclude them from fully staffing extraction sites.

As shown in table 1.9, states vary in the allocation of industry-generated and related revenues and the extent to which they rely on oil and gas monies to fund their general operations. Some states, even those that have actively encouraged development, depend on oil and gas for a tiny fraction of their overall GDP—meaning that they are less dependent on the industry for jobs and growth and may prefer compliance efforts that do not threaten oil and gas's bottom line or raise its costs. Others, including Alaska, Montana, Wyoming, New Mexico, North Dakota, and Oklahoma, rely on oil and gas severance taxes for more than 10 percent of their overall tax revenue (Pless 2012a; 2012b; 2011).

Employment Benefits and Realities

The context surrounding oil and gas compliance may also be influenced by estimated, perceived, and real gains in employment, included in figure 1.7 (BLS 2019). After the discovery of a field, hydrocarbon production requires a small army of engineers, surveyors, managers, supervisors, welders, construction workers and builders, office staff, extractors, drillers and field workers, repair and maintenance workers, machinists, and transporters (Agerton et al. 2017; Considine, Watson, and Blumsack 2010). It should

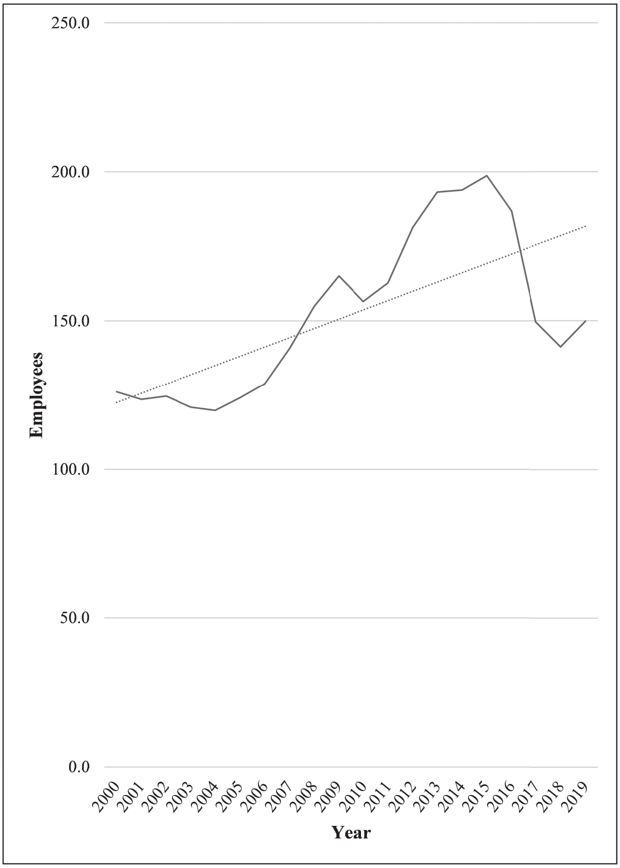


Figure 1.7. Oil and Gas Extraction Employees (in thousands, seasonally adjusted)

be noted that oil and gas extraction also indirectly supports the creation of ancillary jobs, although these numbers are fiercely debated. State policy makers, especially in economically hard-hit states and substate regions, may resist or be hesitant about enforcement efforts that may impede production and potentially harm industry hiring.

Figure 1.7 shows seasonal estimates for jobs directly supported by oil and gas production. Data again shows the years between 2006 and 2014–2015 as a period of steady job growth within the industry, which coincides with the fracking-fueled boom. We should note that figure 1.7 displays job growth overall, but because production is place-specific, these gains were clustered in producing states such as Texas, Pennsylvania, Oklahoma, Ohio, and Colorado.

How many jobs does fracking create? This seemingly innocuous question is at the center of the fracking debate and as a result is also at the heart of the context surrounding compliance. Supporters of oil and gas are quick to focus on optimistic projections and numbers, such as those included in figure 1.7. Opponents, however, argue that such forecasts are inflated and short-lived, and that the number of directly supported industry jobs tends to be much lower (Schulte 2014). Fisk, in 2017, citing Foran (2014), suggests that such arguments are influenced by one's political beliefs and preferences.

> Claims made during the 2014 Pennsylvania gubernatorial race illustrate how murky and challenging generating accurate employment data can be. The incumbent, Republican Tom Corbett, argued that unconventional gas extraction in the Marcellus supported around 200,000 jobs. The state's Department of Labor and Industry, however, reported only 30,000 additional natural gas-related jobs, a number supported by his Democratic opponent. Foran (2014) explained that both numbers could be true, noting that the differences between the two estimates are likely the result of two different definitions of what constitutes an industry-supported job. The Department of Labor's count likely included only those individuals directly involved in production (natural-gas extraction, well drilling, etc.). By comparison, the Corbett campaign's estimation was likely the result of a broader definition of job gains, which included all jobs created by natural gas's supply chain, including its downstream industries, and its impacts to the larger regional economy. (Fisk 2017, 28–30)

Environmental Costs

A common goal for oil and gas agencies is limiting the environmental impacts of oil and gas and preventing future costs. As such, state enforcement of oil and gas rules is likely to be influenced by environmental risks, quality-of-life concerns, and citizen complaints and reporting. These concerns are often amplified in states with a greater number of residents located near production sites and sites in urban areas. In these cases, state or local policy makers may support additional oversight, inspections, and tougher enforcement actions (Fisk 2017).

Specific environmental threats include air particulates and other pollutant emissions, leaking wells, leaking methane, spills from industry facilities, and fluid migration. Environmental threats also include impacts on water quality, such as poor well construction, failing concrete or casings, spills, and fluid migration. Additional environmental impact data from Environment America, an anti-fracking advocacy group, is presented in table 1.10.

As table 1.10 demonstrates, oil and gas production consumes acres of land, contributes to land fragmentation, leads to particulate emissions and contamination, and impacts greenhouse gas emissions (which can support

Table 1.10. Environmental Impacts

Industry's impact	Environmental impact quantified
Wells drilled**	82,000
Number of spills, blowouts, and leaks in 2013 (in 15 top states for onshore oil and gas activity)*	7,662
Water consumed (in billions of gallons)**	250
Chemicals injected since 2005 (in billions of gallons)**	2
Air pollution emitted (in tons)**	450,000
Acres damaged**	360,000

Sources: Reproduced from Fisk 2017 with minor editing for style and clarity; Ridlington and Rumpler 2013**; Soraghan 2015*

the closure of coal power plants but can also contribute to methane emissions). These costs are concentrated in producing states and areas.

Other environmental factors interact with institutional realities and constraints, including several summarized below:

> State oil and gas laws typically require agencies to minimize environmental impacts while also supporting prodevelopment goals, meaning that agencies must address multiple goals without necessarily having certainty on how to balance said goals.
>
> Many rules are designed to minimize environmental harms to an acceptable risk level without imposing burdensome costs on producers. However, it is an open debate as to what constitutes acceptable risk, as risk levels are often idiosyncratic and can be outside the control of regulators.
>
> Interest groups often use environmental contamination, violations, and any bad behavior in the industry as their political weapons of choice to push for desired changes, including how laws are enforced (Fisk 2017).
>
> The precise cause of environmental contamination can be difficult to determine. This is true especially if predrilling data is not available, if an agency's testing capacities are not current, if they are not allowed to test for certain contaminants, or if there are multiple contaminants or naturally occurring chemicals.

The stage of production also shapes fracking's environmental footprint. Throughout the production life cycle, opponents argue that operators release

Site preparation and construction	Drilling and hydraulic fracturing	Site closure
• Dust and other emissions from site construction, including pads and roadways • Truck traffic	• Chemical spills/leaks • Venting/flaring • Methane leaks • Dust/silica from sand • Use of diesel engines and compressors	• Improper storage • Pipe and casing failures

Figure 1.8. Possible Points of Air Contamination

Site preparation and construction	Drilling and hydraulic fracturing	Site closure
• Runoff from construction into municipal stormwater systems • Chemical spills	• Chemical spills • Casing and cement failures • Improper storage • Pipe failures	• Improper storage • Unlined pits • Pipe failures

Figure 1.9. Possible Points of Water Contamination

a variety of harmful air emissions. These include air particulate emissions, smog-inducing chemical compounds, and gases tied to climate change—often from methane leaks, flaring, and venting, as presented in figure 1.8 (EPA 2018).

Critics also contend that oil and gas production harms water quality, as shown in figure 1.9. Researchers have noted that oil and gas's greatest threat to surface waters is primarily through site runoff, accidents, and spills. Groundwater quality can be impacted via surface spills, leaking wastewater pits, or other poor disposal practices. In more rare circumstances, poor well construction or casing failures may permit fluids to migrate into adjacent formations (Intermountain Oil and Gas BMP Project 2016).

The connection between water contamination and unconventional oil and gas production has long concerned stakeholders; however, cases of actual contamination are fairly rare.

> Between 2005 and 2014, Pennsylvania Department of Environmental Protection regulators concluded that unconventional oil and gas operations accounted for 106 cases of drinking water well contamination.
>
> Between 2010 and 2013, Ohio Department of Natural Resources regulators confirmed six cases of water pollution traced back to oil and gas operations but could not isolate fracking as the sole cause.
>
> Between 2010 and 2014, West Virginia regulators identified four cases of contamination related to oil and gas operations (Begos 2014).

Figures 1.8 and 1.9 show the array of possible sources of contamination and the various points during which operations may harm the environment. Looking closely, both figures reveal that risks are present before, during, and after fracturing. This presents challenges to compliance, as many state agencies have prioritized compliance activities during certain points of the production life cycle (e.g., its productive phase compared to others). In a similar way, operators are more likely to be present at actively producing sites than at marginal wells. However, contamination (and likely the result of an environmental violation), can take place before a well is spudded or after a well is no longer producing.

Public Health

Research is still ascertaining and evaluating possible connections between negative public health outcomes and distance from oil and gas sites. This relationship is key, as protecting public health is a core component of many states' oil and gas policies, and as a result, protecting public health is a key piece of compliance. Yet, unpacking this link has proven to be difficult, as evidence is often mixed, and administrative responsibilities may be shared with a state health agency (instead of an oil and gas agency). The lead researcher of a recent Colorado study, Lisa McKenzie, for example, concluded that closer proximity to oil and gas wells was linked to an increased exposure to benzene, a known carcinogen (Fisk 2017). McKenzie explained, "We do know that concentrations of hazardous air pollutants like benzene are closer to these oil and gas well sites. So it's not surprising that the health risks are also higher as you get closer to those sites" (Hood 2018). State health officials countered that "they have not detected elevated health risks from the benzene and other hydrocarbons measured in McKenzie's study" (Hood 2018).

Surface-Level Disruptions

Rabe and Borick (2013) identified several ways that oil and gas development impacts quality of life for nearby residents, such as increased truck traffic, vehicular congestion, damaged infrastructure, crime, increased noise, venting and flaring, spills, and dust contamination during construction and operations. These concerns have also worked into state supreme court decisions:

> The Pennsylvania State Supreme Court observed that prior to discovery and development of the Marcellus Shale, cities had enacted zoning plans and other land use policies reflective of their values and preferences. Such policies served as a foundation for what residents expected for their community and quality of life. Act 13, according to the plurality opinion, "fundamentally disrupted those expectations, and ordered local government[s] to take measures to effect the new uses, irrespective of local concerns." *Robinson Twp., Washington County v. Commonwealth*, 83 A.3d 901 (Pa. 2013).
>
> New York justices also articulated concerns for residents' quality of life. In *Wallach v. Town of Dryden*, New York's highest court determined that the Town of Dryden evaluated drilling and concluded that, if allowed, it would harm the community's "deliberately cultivated, small-town character." This determination, the court concluded, should be protected (Fisk 2017).

Many of these aspects (e.g., truck routes or times in which operators may flare a well) are addressed in applicable permits. As such, they are subject to citizen complaints as well as inspections, violations, and administrative activities.

Land Fragmentation

Oil and gas operators often divide production sites into a crisscrossing pattern that breaks up large swaths of previously undeveloped land. Known as land fragmentation, this environmental harm is particularly problematic in states such as Pennsylvania and Ohio. In a study of energy development in Lycoming County, Pennsylvania, for example, the United States Geological Survey observed that the area's forests are home to a variety of species that struggle when they are located near human populations. Land fragmentation also harms ecosystem services (provided by large intact forests) such as controlling insect populations, purifying water, offering recreational opportunities, storing carbon and greenhouse gas emissions, and offering aesthetic value to citizens (Cusick 2017). In some states, lawmakers have taken steps to mitigate the impacts of land fragmentation especially when it involves endangered species. In Pennsylvania, for example, when operators seek to drill within forests, they must follow rules under the Pennsylvania Natural Heritage Program, which requires that the project be analyzed for its impacts on "threatened, endangered, and special concern species and resources" (Abrahams, Griffin, and Matthews 2015, 154). Although it should be noted that environmental impact research does not necessarily stop development.

Waste Management and Safety

Fracking produces waste products that can fall under federal, state, and local regulation, although specific regulation depends on the type of disposal, the operator, and the jurisdiction (Shankman 2010). Common disposal methods are recycling for future uses or extraction efforts, treating and discharging into surface waters, injecting it into underground Class II wells (more likely to be federally regulated), storing in (usually lined) open-air wastewater pits (likely to be state regulated), and spreading it onto roads for ice or dust control (more likely to be locally regulated).

According to the Environmental Protection Agency (2016; n.d.), "Wastewater management choices are affected by cost and other factors, including: the local availability of disposal methods; the quality of produced water; the volume, duration, and flow rate of produced water; federal, state, and local regulations; and well operator preferences. Available information suggests that hydraulic fracturing wastewater is mostly managed through injection in Class II wells." Veil (2015) estimated that approximately 93 percent of produced water from the oil and gas industry was injected into Class II wells in 2012.

The EPA (2016a; n.d.) has identified potential risks for various disposal practices, but especially for produced waters stored above ground. The agency noted:

> Above ground disposal of hydraulic fracturing wastewater has impacted the quality of groundwater and surface water resources in some instances. In particular, discharges of inadequately treated hydraulic

> fracturing wastewater to surface water resources have contributed to elevated levels of hazardous disinfection byproducts in at least one downstream drinking water system. Additionally, the use of lined and unlined pits for the storage or disposal of oil and gas wastewater has impacted surface and groundwater resources. Unlined pits, in particular, provide a direct pathway for contaminants to reach groundwater. Wastewater management is dynamic, and recent changes in state regulations and practices have been made to limit impacts on groundwater and surface water resources from the aboveground disposal of hydraulic fracturing wastewater.

Researchers have tied a small number of Class II underground injection wells to episodes of induced seismicity (Ellsworth 2013).

Infrastructure

Oil and gas operations rely on a small fleet of heavy trucks, a variety of personnel and skills, possibly new roads, chemicals, water, sand, and industrial equipment such as compressors to extract oil and gas resources. At the height of production, extraction sites are busy and necessitate frequent trips to and from various facilities. The combination of frequent trips, heavy trucks, and infrastructure not designed for such traffic can exacerbate challenges associated with already stressed infrastructure. A RAND study found the following:

> Road maintenance and repair costs ranged between $13,000 and $23,000 per well, not including any road maintenance agreements. Once factored road maintenance agreements were included, the study concluded infrastructure costs of between $5,000 and $10,000 per well. Based on data presented in chapter 4, in some years, operators drilled more than a thousand wells, meaning repair costs can exceed $1 million quickly (Samaras 2014).
>
> Fisk (2017) cited a New York study concluding that if the state permitted fracking, infrastructure repair costs would range between $211 and $378 million.

SUMMARY AND CONCLUSIONS

The contextual environment shaping oil and gas compliance is influenced by organizational mission, the timing of operations, external events, new and emerging technologies, data needs and availability, budgetary and personnel-related demands, political priorities, and economic needs. New technologies, for example, have made it possible for operators to drill thousands of new wells and for inspectors, subject to resource availability, to efficiently submit their inspection reports. Novel technologies, however, have not eliminated the need to inspect wells built fifty years or one hundred years ago. Similarly, new production has led to job growth but also created new environmental threats requiring additional competencies and training for inspectors. Political leadership has responded to this changing environment. Some elected officials, for example, are largely supportive of extraction, whereas others have urged caution and preached the importance of environmental protection. Administrative agencies have also felt the competing pulls of the contextual environmental surrounding oil and gas production. Centralized offices may have different priorities than their regional counterparts. Frontline staff may also hold different values, knowledge, resources, and priorities than executive-level personnel. These differences may be even greater when administrative staff is compared to the private sector. Yet, all are involved in compliance.

Thus, when it comes to oil and gas, compliance is neither a simple task nor one that only involves today's best management practices. As an industry, oil and gas's legacy dates to the nineteenth century (Fisk 2017). It is this historical footprint, when combined with the missions of oil and gas agencies, the type and age of the well, budgetary and political pressures, and limited human resources, that challenges applicable state agencies charged with ensuring compliance.