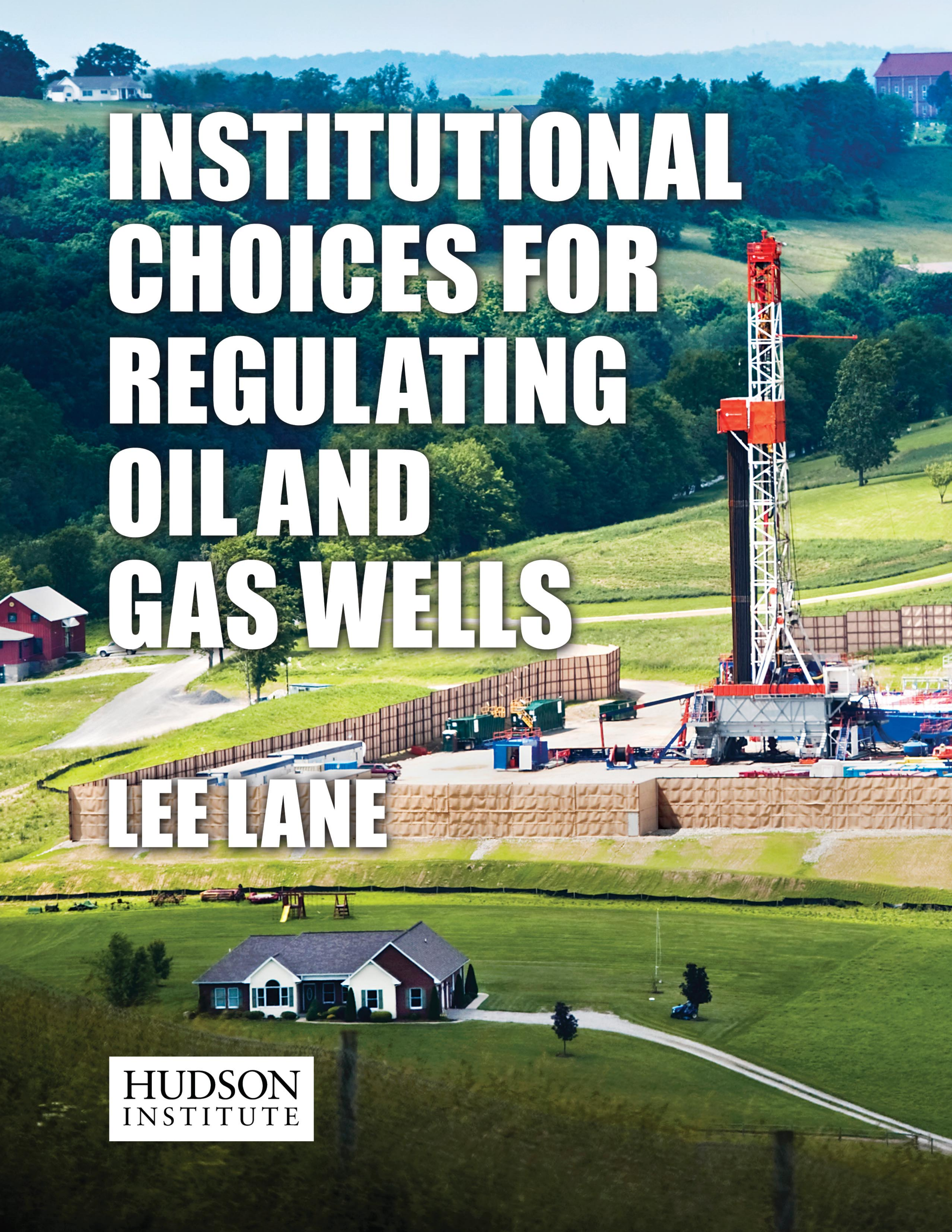

INSTITUTIONAL CHOICES FOR REGULATING OIL AND GAS WELLS

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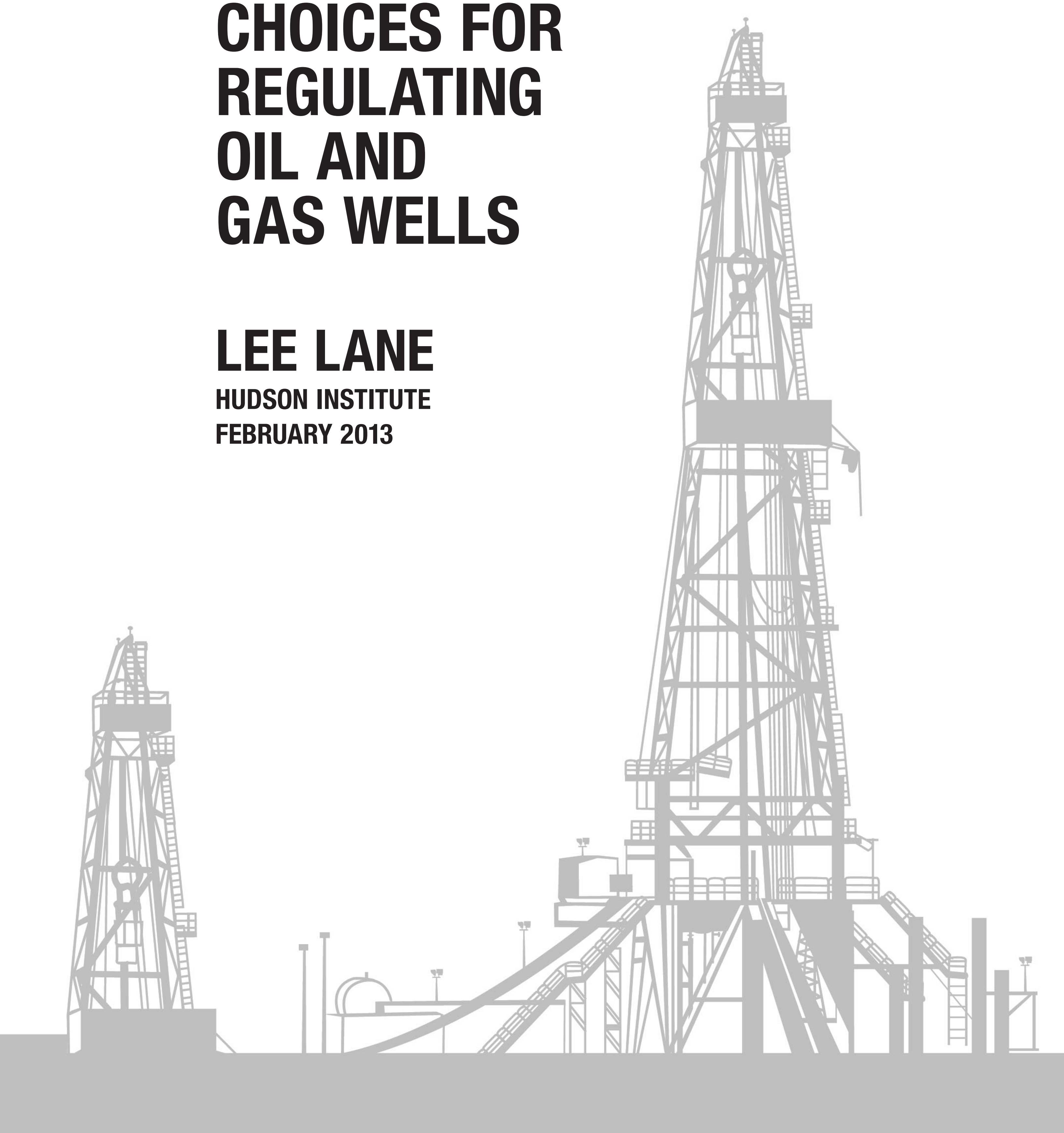

EXECUTIVE SUMMARY

"The FRAC Act proposals raise a broader question. In the regulation of oil and gas development, what should be the proper division of labor between Washington and the states in limiting harmful environmental side-effects?"

Hydraulic fracturing (HF) is one of the technologies that have enabled large increases both in the current production of natural gas and in estimates of recoverable reserves. However, as new technology has triggered a boom in onshore U.S. gas exploration and production (E&P), environmental concerns have multiplied. Much of the concern centers on use of HF. As public concern has risen, so have calls for federal regulatory control. The Interior Department has adopted tighter controls on the use of HF on public lands. Also, two former Obama White House aides, Carol Browner and Jody Freeman, have argued for more EPA regulation of all use of HF in oil and gas drilling. To achieve this control, they propose to repeal the partial oil and gas exemption under the Safe Drinking Water Act (SDWA). Bills to this effect, dubbed the FRAC Act, were proposed in the last two Congresses, but they were not adopted.

Clearly, the nation can reap large benefits from exploiting its natural gas resources. GDP, national security, and the environment all stand to gain. It is also true that, to maximize net benefits, the public sector should limit the environmental side effects of finding and producing natural gas. Proposals for greater federal control, however, raise a basic question: What should be the division of labor between Washington and the states?

The answers to four questions will largely determine the division of labor that is most likely to maximize society's welfare. First, do the environmental problems involve large trans-border effects? Second, would uniform standards protect large network or scale economies in the affected industry? Third, which level of government is likely to possess better information? Fourth, is the federal government more attentive to the public welfare than the states are?

With regard to most but not all aspects of U.S. onshore natural gas production, these considerations imply that state-level control is a superior option. They also suggest that, given current evidence, the case for the FRAC Act is weak. Other federal actions may, however, be justified.

Both federal and state regulation are imperfect and likely to remain so. Improvements, though, are possible; indeed, they are taking place. The complex nexus of economic and environmental issues involved with oil and gas E&P are likely to frustrate efforts like the FRAC Act to impose simple sweeping schemes. Still, at least three principles seem to offer a useful path forward. First, in weighing the proper federal/state division of labor, one should consider both options' imperfections. Second, in light of real-world resource constraints, prioritize problems. Third, apportion tasks with a view toward exploiting the known strengths of each level of government.

1. INTRODUCTION

The United Sates is in the midst of a boom in natural gas production. Progress in HF technology is a key factor in enabling this boom. However, some in Congress and elsewhere are now demanding that EPA regulation of HF be greatly expanded.

"The progress in shale gas development has caused a near doubling of estimated total, technically recoverable, natural gas reserves."

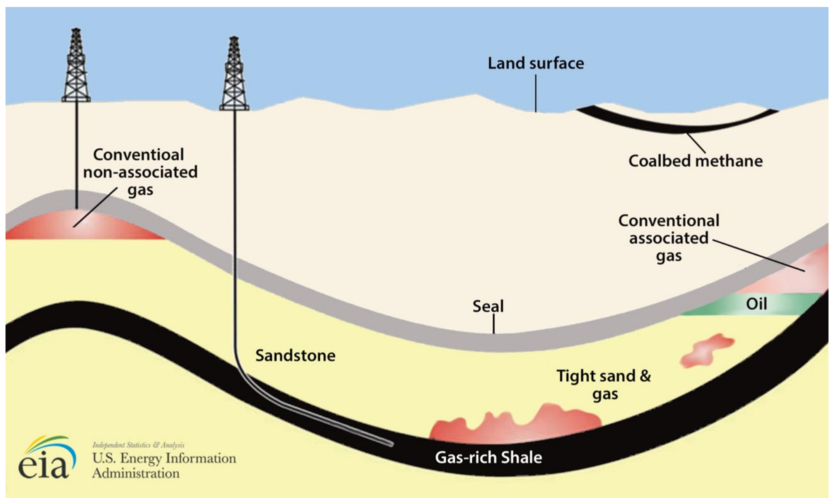

FIGURE 1.
Schematic Geology of Natural Gas Resources. Source: U.S. Energy Information Administration and U.S. Geological Survey.

1.1. Hydraulic Fracturing

The U.S. oil and gas industry continues to make great strides in technology. Striking advances in horizontal drilling, 3D seismology, and hydraulic fracturing have been on the leading edge of this trend. One effect has been to greatly lower the costs of producing unconventional oil and gas. Unconventional gas includes (1) shale gas, i.e. gas trapped in the pores in shale rocks, (2) tight natural gas found in low porosity sandstones or carbonate reservoirs, and (3) coalbed methane within coal seams or the surrounding rock.

As the costs of extracting these resources have fallen, economically recoverable gas reserves have risen. Growth in recoverable shale gas reserves has had a particularly large effect on the projected size of the total resource base. In fact, the progress in shale gas development has caused a near doubling of estimated total, technically recoverable, U.S. natural gas reserves (U.S. Energy Information Administration 2011).

Already, the output of shale gas has surged. Between 2006 and 2010, yearly shale gas output increased almost fivefold, from 1.0 to 4.8 trillion cubic feet; by 2010, shale gas accounted for 23 percent of total U.S. gas output. By 2035, total U.S. gas production is projected to reach 27.9 TCF; of that, shale gas will account for 13.7 TCF, or 49 percent. (U.S. Energy Information Administration 2012)

This rise in natural gas output would have been impossible without HF. HF involves injecting a fluid under high pressure into wells. Injection opens cracks and fissures in oil- or gas-bearing rock formations and keeps them open. In this way, HF accelerates the pace of oil and gas production. It also raises the percentage of the resource that can ultimately be recovered. By developing resources faster and more completely, HF makes it profitable to tap reserves that otherwise would have to be left in the ground.

The fluid injected during HF is primarily a mix of water and sand. Small volumes of chemicals can be added. The mix of chemical additives used in HF is site specific. In determining which chemicals to use, well operators weigh many factors. Considerations include shale thickness, stress, compressibility, and rigidity. Some firms have invested in gaining proprietary knowledge about effective "recipes." Such investments have helped to propel the productivity gains that have enabled the shale gas boom, and progress is continuing.

1.2. Benefits of the Shale Gas Revolution

The shale gas boom, if government policy allows it to proceed, offers vast benefits. The economic gains are patent. Large benefits in national and global security are also in the offing. And the boom will also help to dampen growth in global warming emissions.

The U.S. natural gas market is highly competitive. Hence, as shale gas productivity and production have risen, natural gas prices have fallen. Several major shale gas basins are close to consumption centers and to links with the U.S. gas pipeline network. These factors, too, help to hold down costs. Over time, though, natural gas prices are projected to rise gradually (U.S. Energy Information Administration 2012).

Nonetheless, natural gas is expected to represent a major long-run competitive advantage for the U.S. economy. The scale of that advantage will hinge in part on technological uncertainties. It will, however, also depend on the regulatory environment that government creates (Medlock 2011).

“The impact of shale gas on global markets is likely to amplify its environmental benefits. U.S. shale gas development will not only hold down U.S. natural gas prices; its effects on prices will be global. By inference, it will also tend to push energy choices abroad toward natural gas instead of coal.”

Economic gains are likely to diffuse extensively. Major shale gas basins are widely distributed across the lower 48 states. By 2010, 23 states were producing at least some shale gas (U.S. Energy Information Administration 2012).

On the demand side, natural gas supplies roughly 22 percent of all U.S. energy. It is a major fuel source for the industrial, commercial, electric power, and residential sectors. Large industrial users include producers of pulp and paper, metals, and chemicals; petroleum refineries; and food processing plants. Natural gas is also a feedstock for products like plastics, chemicals, and fertilizers. The public sector too stands to reap hefty gains in growth-generated tax revenues (Ground Water Protection Council; ALL Consulting 2009).

Furthermore, for at least the next two decades, the shale gas boom promises to virtually eliminate the need for natural gas imports. Absent the rising trend in shale gas output, imports of liquefied natural gas (LNG) would rise. Those imports would compound existing U.S. balance of trade problems. Without LNG imports, U.S. terms of trade should improve.

U.S. shale gas development also offers major national security advantages. Without the prospect of shale gas, the United Sates was slated to grow increasingly reliant on LNG imports. Many such imports would be from unstable and sometimes hostile regions. Shale gas has pushed such developments well into the future. In effect, the shale gas boom allows the United Sates to avoid compounding its oil dependence problems with a new problem of gas dependence (Medlock 2011).

In fact, the effects of U.S. shale gas development are global. By forestalling the rise of a U.S. LNG import market, the shale gas boom will curtail the global market power of the large gas exporters such as Russia, Iran, and Qatar. If these countries' share of the world market shrinks, the threat that they will form an OPEC-like natural gas cartel also falls.

Similarly, rising U.S. shale gas output tends to limit the scope for coercive natural gas diplomacy. Russia has already used its control of natural gas supplies to coerce Ukraine and other states. With a tight global LNG market, the use of energy supplies as a political weapon might well spread. U.S. shale gas may weaken this tendency. Without U.S. shale gas, the 2040 expected combined world market share of natural gas for Russia, Iran, and Venezuela would be about 33 percent. With shale gas, these countries' projected share will fall to about 26 percent (Medlock 2011).

The use of natural gas in power plants and in industrial boilers offers important environmental gains. The substitution of natural gas for coal also reduces sulfur dioxide and particulate emissions that cause more immediate harm to health and property. Also, compared to coal, natural gas generates half the emissions of the main manmade global-warming gas, CO_2. Rising natural gas output, therefore, contributes to the gradual decline in U.S. CO_2 emissions that is projected to take place in the coming decades (U.S. Energy Information Administration 2012). The extent of the emission reduction remains subject to some uncertainty about fugitive emissions from drilling operations. Such emissions, however, represent a financial loss to the well operators as well as a regulatory concern; hence, industry has strong motives for abating them, and as technology improves, drillers will probably find new ways of doing so.

"Both Browner and Freeman argue that federal regulation is a sine qua non for overcoming public resistance to HF, and, on that basis, that full exploitation of U.S. natural gas reserves depends on it."

The impact of shale gas on global markets is likely to amplify its environmental benefits. As just noted, U.S. shale gas development will not only hold down U.S. natural gas prices; its effects on prices will be global. By inference, it will also tend to push energy choices abroad toward natural gas instead of coal. Most power plant construction is slated to take place in fast-developing, middle-income economies such as China and India. To the degree that the disappearance of U.S. import demand affects natural gas prices in these countries, the environmental gains will be global.

1.3. Proposals to Federalize Regulation

Despite the manifest benefits of the natural gas boom, some in the Congress have proposed that the U.S. Environmental Protection Agency (EPA) establish new controls over HF. Carol Browner and Jody Freeman, two former top Obama White House aides, have both strongly supported this move. In a *New York Times* opinion piece, Professor Freeman has called on Congress to mandate new EPA standards. (Freeman 2012) The goal would be EPA regulation of the effects of HF on underground water resources. Ms. Browner has made clear that she, too, thinks uniform standards on HF are needed (Little 2012).

Professor Freeman observes that HF, if performed improperly, may "pollute surface and drinking water and emit dangerous air pollution." She freely admits that many states are now responding to the growing use of HF by changing both their laws and their regulatory systems. She dismisses these efforts, though, as leading to a patchwork. Browner also laments the diversity of state regulations. She claims that industry needs a single set of regulations (Little 2012). And she has warned that pollution can cross state lines (Browner 2012). Both Browner and Freeman argue that federal regulation is a sine qua non for overcoming public resistance to HF, and, on that basis, that full exploitation of U.S. natural gas reserves depends on it.

Several members of Congress hold similar views, and they have introduced bills that would expand EPA control of HF. EPA control of this process is now limited. The Energy Policy Act of 2005 exempted some oil and gas HF operations from regulation under the Safe Drinking Water Act (SDWA). Bills to repeal this exemption have been introduced in both houses of Congress.

This legislation has been dubbed the Fracturing Responsibility and Awareness of Chemicals Act (FRAC Act). Similar bills have been introduced in each of the last two Congresses. These bills would repeal the oil and gas industry's partial exemption from EPA regulation under the SDWA. They would require the oil and gas industry to disclose to the public all of the constituents of the chemicals used in HF. Under certain conditions, they would also require firms to disclose to medical and emergency personnel the (sometimes proprietary) formulas of the chemicals used in HF.

Should repeal be enacted, the EPA would impose new minimum standards on HF. In that case, Professor Freeman suggests, the new federal rules would most likely allow states freedom to enforce rules more stringent than the EPA's. Also, states that could prove that they would at least enforce the EPA standards could continue to regulate HF. However, where states did not convince EPA that their regulations were adequate, the Agency would assert federal control.

2. The Proper Scope of Federal Regulation

Thus, the FRAC Act proposals raise a broader question. In the regulation of oil and gas development, what should be the proper division of labor between Washington and the states in limiting harmful environmental side-effects? Questions of this kind have been discussed extensively in the economic literature.

That discussion has led to a consensus that, if the goal is to maximize social welfare, one should apply four key tests in finding the right division of labor. First, how important are any trans-boundary effects? Second, to what degree would disparate standards disrupt the network or scale economies in the regulated activities and in the process of regulation? Third, which level of government will be most efficient in acquiring the information needed to support good decisions? Fourth, is there a reason for believing that federal rather than state actions more closely correspond to the broad public interest? The following analysis will address these questions with respect to the FRAC Act; however, the same logic could and should apply to other schemes to super-impose federal standards on state-level regulation.

2.1. The Question of Trans-Boundary Effects

The first presumption behind the FRAC Act is that toxic chemicals injected as part of HF operations will migrate into drinking water sources. The degree to which injection of fracturing fluids threatens drinking water remains in dispute. And the issue is the subject of continuing research. Nonetheless, researchers have already completed a number of studies. A recent report by the Government Accountability Office (GAO) has found no evidence that fracturing fluids have in fact contaminated drinking water. GAO summarizes a number of studies:

From 2001 through 2010, an industry consulting firm monitored the upper and lower limits of hydraulically induced fractures relative to the position of drinking water aquifers in the Barnett and Eagle Ford Shale, the Marcellus Shale, and the Woodford Shale. In 2011, the firm reported that the results of the monitoring show that even the highest fracture point is several thousand feet below the depth of the deepest drinking water aquifer. For example, for over 200 fractures in the Woodford Shale, the typical distance between the drinking

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water aquifer and the top of the fracture was 7,500 feet, with the highest fracture recorded at 4,000 feet from the aquifer. In another example, for the 3,000 fractures performed in the Barnett Shale, the typical distance from the drinking water aquifer and the top of the fracture was 4,800 feet, and the fracture with the closest distance to the aquifer was still separated by 2,800 feet of rock (Government Accountability Office 2012).

GAO also relates a Pennsylvania study result:

In 2011, the Center for Rural Pennsylvania analyzed water samples taken from 48 private water wells located within about 2,500 feet of a shale gas well in the Marcellus Shale. The analysis compared pre-drilling samples to postdrilling samples to identify any changes to water quality. The analysis showed that there were no statistically *significant increases in pollutants prominent in drilling waste fluids —such as total dissolved solids, chloride, sodium, sulfate, barium, and strontium—and no statistically significant increases in methane. The study concluded that gas well drilling had not had a significant effect on the water quality of nearby drinking water wells* (Government Accountability Office 2012).

A third study related by GAO, by yet another team of researchers, reports results from both Pennsylvania and New York:

"No evidence currently suggests that HF operations are causing serious or widespread contamination of drinking water. No evidence exists that contamination is causing trans-boundary effects, let alone that they are major. Insofar as problems may exist, they appear to stem from the risk of surface spills or poor well construction, issues that are already within the purview of existing regulatory regimes."

In 2011, researchers from Duke University studied shale gas drilling and hydraulic fracturing and the potential effects on shallow groundwater systems near the Marcellus Shale in Pennsylvania and the Utica Shale in New York. Sixty drinking water samples were collected in Pennsylvania and New York from bedrock aquifers that overlie the Marcellus or Utica Shale formations—some from areas with shale gas development and some from areas with no shale gas development. The study found that methane concentrations were detected generally in 51 drinking water wells across the region—regardless of whether shale gas drilling occurred in the area—but that concentrations of methane were substantially higher closer to shale gas wells. However, the researchers reported that a source of the contamination could not be determined. Further, the researchers reported that they found no evidence of fracturing fluid in any of the samples (Government Accountability Office 2012).

A fourth study, this time in Texas, was done under the aegis of the Groundwater Protection Council, (GWPC) a nonprofit association of state regulators of groundwater quality. GAO describes its findings as follows:

In 2011, the Ground Water Protection Council evaluated state agency groundwater investigation findings in Texas and categorized the determinations regarding causes of groundwater contamination resulting from the oil and gas industry. During the study period—from 1993 through 2008—multistaged hydraulic fracturing stimulations were performed in over 16,000 horizontal shale gas wells. The evaluation of the state investigations found that there were no incidents of groundwater contamination caused by hydraulic fracturing (Government Accountability Office 2012).

Supplementing their literature search, GAO met with regulatory officials in a diverse sample of states: Arkansas, Colorado, Louisiana, North Dakota, Ohio, Oklahoma, Pennsylvania, and Texas. The state officials based their conclusions on state investigations. In all eight states, the judgment was that the hydraulic fracturing process has not been found to be a cause of groundwater contamination within their states (Government Accountability Office 2012).

Summarizing evidence from the United States and elsewhere, a joint report of the British Royal Society and the Royal Academy of Engineering summarized the risks of water contamination from shale gas development in the following terms:

Concerns have been raised about the risk of fractures propagating from shale formations to reach overlying aquifers. The available evidence indicates that this risk is very low provided that shale gas extraction takes place at depths of many hundreds of meters or several kilometers. Geological mechanisms constrain the distances that fractures may propagate vertically. Even if communication with overlying aquifers were possible, suitable pressure conditions would still be necessary for contaminants to flow through fractures. More likely causes of possible environmental contamination include faulty wells, and leaks and spills associated with surface operations. Neither cause is unique to shale gas. Both are common to all oil and gas wells and extractive activities (The Royal Society and The Royal Academy of Engineering 2012).

Three policy inferences follow from the U.S. and UK literature reviews. First, no evidence currently suggests that HF operations are causing serious or widespread contamination of drinking water. Second, a fortiori, no evidence exists that contamination is causing trans-boundary effects, let alone that they are major. Third, insofar as problems may exist, they appear to stem from the risk of surface spills or poor well construction, issues that are already within the purview of existing regulatory regimes.

2.2. Weak Network, Scale Economies

Much of the discussion of the FRAC Act seems to assume that uniform regulation is good per se. Both Ms. Browner and Professor Freeman assert this to be the case. But is it?

To be sure, uniform standards can sometimes benefit the regulated industry and its customers. For instance, large economies of scale are present with automobile assembly. There, long production runs greatly lower unit costs. Or in the case of railroads, or of the electric power grid, network economies are vital.

With such network industries, all else being equal, allowing rolling stock or current to move freely across the entire network minimizes costs. In such a case, diverse regulatory regimes might drastically raise costs. Thus, auto makers have pleaded for uniform air pollution and fuel mileage standards. And railroads have long supported federal preemption of state regulations.

In contrast, oil and gas producers have shown no such support for federal preemption. Their industry does not display the large scale and network economies that make uniform standards so vital in other cases. Doubtless the oil and gas firms that operate across state lines would prefer more uniform regulatory paperwork and procedures. The problems posed by diverse standards, though, do not even approach the level of those implied by shortened auto production runs or rail gauges that vary from state to state.

In any case, the FRAC Act does not actually promise regulatory uniformity. To the contrary, under the proposed bills, a state where NIMBY sentiments run strong could still adopt highly restrictive standards. Indeed it could still ban all drilling or all use of HF in oil and gas operations. The standardization envisioned by the bills works only to force states to raise their demands on industry. It does nothing to blunt the threat of irrationally strict mandates.

Thus, observers who tout uniformity as a virtue in and of itself have lost sight of just what it is that makes uniform standards desirable. In the instance of oil and gas drilling, it would be of only quite modest value. Be that as it may, the issue is largely moot since the FRAC Act provides little in the way of genuine uniformity.

2.3. The Information Challenge of Regulation

Hayek's *Constitution of Liberty* showed that the high cost of information caused economic planning to fall far short of optimal outcomes. Coase's work showed that environmental planning faces at least equally severe problems of the same type (Coase 1988). By inference, then, the level of government most likely to have the relevant information is a weighty factor in deciding where control should rest. On this basis, past studies of drinking water standards have tended to favor decentralized approaches.

Considerations of information highlight the advantages of a decentralized approach to setting standards. The per-household cost of treating drinking water varies greatly among communities—particularly *with differences in the size of water systems. Preferences for protecting drinking water also vary among communities. Local governments are therefore in the best position to choose drinking water standards that reflect those variations in costs and preferences* (Dinan and Tawil 1997).

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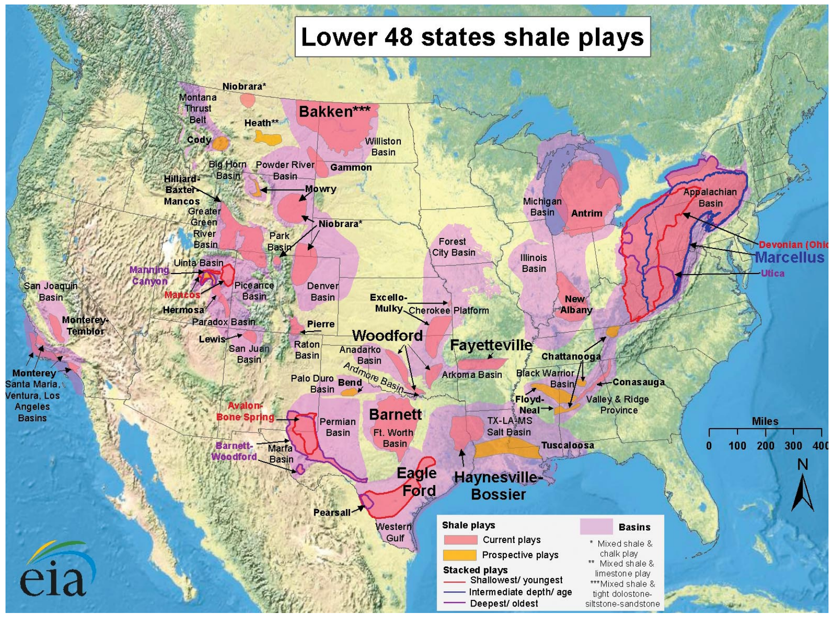

FIGURE 2.
Source: Energy information Administration based on data from various published studies. Updated May 2011.

The vast disparities among major natural gas plays further magnify the case for decentralized control and diverse standards. Certainly with shale gas, geology, hydrology, and climate differ greatly from one shale basin to another. Some shale plays are actually in metropolitan areas; others are far from population centers. In some basins, water is plentiful; in some it is scarce. Water laws are diverse; so is the quality of local infrastructure and the demands it must satisfy.

Of course, state laws and bureaucratic structures also vary greatly. Indeed, disparate conditions can prevail even within a given basin: "[A]cross a single play or play sub-area there can be significant variations in depth, thickness, porosity, carbon content, pore pressure, clay content, thermal maturity, and water content" (U.S. Energy Information Administration 2011).

Variance occurs over time as well as through space. Recently, for instance, major firms have begun to expand their stakes in shale gas production; these firms have heavy investments in reputation as well as access to copious capital (Gény 2010). To date, the trend has been limited, but as it continues it is likely to lighten some of the burdens faced by public sector regulators (Gény 2010). Technology and scientific knowledge are also rapidly evolving (U.S. Energy Information Administration 2011).

With such variance across space and time, even were the regulator to somehow hit upon the right balance, *for the average case*, both the marginal costs of abatement and its marginal benefits are certain to vary greatly with place and time. So what is right on average is likely to be very badly wrong in most or all specific cases (Davis and Kamien 1972). And should a standard nevertheless somehow prove optimal at one point in time, it will soon cease to be.

Ms. Browner and Professor Freeman wish EPA to circumvent this problem. Professor Freeman suggests that the agency should adopt "general 'performance standards' rather than detailed specifications." And, it is possible, at least under some administrations, that EPA might choose to regulate with a lighter-than-usual hand.

However, simply invoking performance standards does not solve the problem. First, making informed judgments about when a given state regulator is performing well and when it is not requires vast amounts of local knowledge which EPA appears not to possess. Second, the phrase "performance standards" begs several questions. How closely, for instance, should EPA attempt to oversee the states? A prescriptive and demanding stance seems to guarantee a sharp increase in regulatory transaction costs and costly regulatory uncertainty. Yet a loose regime seems to be sharply at odds with the political rhetoric surrounding HF. Third, some provisions of the SDWA may make a more deferential EPA regime hard to implement. Section 3.1. below will discuss this issue further.

2.4. Federalism and the Public Interest

One other argument is sometimes cited to defend federal preemption. It is the claim that federal policies take more care of public welfare than do those made at the state level. States, for instance, are sometimes thought to sacrifice public welfare in the competition to attract industries that bring jobs and tax revenue. But even if these claims are accepted at face value, their implications for policy remain opaque.

Another question economists have to consider in this regard is whether states or localities would be likely to choose less-than-optimal standards to attract industry to their area. Although that issue is potentially important, the evidence to support federally determined standards to avoid such a situation is not particularly compelling… Finally, federally determined standards might not be efficient even if local standards that were likely to result in their absence were inadequate. Although federal regulations may make communities that would otherwise have inadequate standards better off, they may make others worse off—for *example, communities for which the federal standard is higher than justified by the relevant costs and benefits* (Dinan and Tawil 1997).

Conventional wisdom also has it that the federal government is more responsive to environmental advocates than are the states (Revesz 1992). Again, though, the policy implications here are ambiguous. In fact, in many cases environmental policy entrepreneurs combine with news media sensationalism to create bandwagon effects in public opinion.

The result is often that public panics lead to policy overreaction. Such panics have caused large and lasting distortions in public policy. Examples include Love Canal, Alar, Agent Orange, asbestos in schools, and automobile airbags that endanger children. In these cases, responsiveness has led to costly policy mistakes (Kuran and Sunstein 1999). It may be, then, that environmental groups have more sway at the federal level. Whether that is a plus or a minus remains unclear.

"Were the FRAC Act to become law, EPA and the states would need, at minimum, to write and enforce new regulations. Also, the federal underwater injection control program requires EPA or state authorities to provide a public hearing before each permit is issued, and to have inspectors on site thereafter. The implied large increase in the number of wells to be permitted, therefore, would demand a comparable rise in staff levels."

3. Practical Environmental Federalism

In light of the just-discussed theoretical literature, none of the valid grounds for federal preemption appears to apply in the case of the kinds of problems supposedly addressed by the FRAC Act. Even so, proponents of more federal control of oil and gas E&P can point to a wide variety of environmental problems that have trailed in the wake of the current boom. Perhaps more to the point, the state regulatory system is manifestly subject to a number of defects. It seems plain that the status quo is less than optimal. What then should be done?

The complex nexus of economic and environmental issues involved clearly defies efforts like the FRAC Act to impose simple sweeping schemes. Still, at least three principles seem to offer a useful path forward. First, in weighing the proper federal/state division of labor, consider both options' imperfections. Second, in light of real-world resource constraints, prioritize problems. Third, apportion tasks with a view toward exploiting the known strengths of each level of government.

3.1. The FRAC Act and the "Nirvana Fallacy"

The severity of the problems with the existing regulatory regime of oil and gas E&P is the subject of much doubt and dispute; still, few would maintain that it is flawless. The truth is, though, that no institution ever perfectly maximizes welfare (North 1990). Yet analysts sometimes compare the costs and benefits of an extant institution—with all its defects—to those of an imagined ideal alternative. The mistake is so common that economists have coined a term for it: the "Nirvana fallacy."

It makes sense, then, to think about likely problems with the FRAC Act, or any other federal measure, in weighing the choice between federal and state regimes. At least two sets of issues would seem to raise red flags. One is fiscal. The other pertains to the risk that it will trigger an explosion of litigation.

Fiscal constraints would be a major factor in determining the FRAC Act's effects. The proposed legislation may well impose heavy new regulatory burdens on the EPA. But federal fiscal austerity is likely to curtail the agency's resources.

Were the FRAC Act to become law, EPA and the states would need, at minimum, to write and enforce new regulations. Also, the federal underwater injection control program requires EPA or state authorities to provide a public hearing before each permit is issued, and to have inspectors on site thereafter. The implied large increase in the number of wells to be permitted, therefore, would demand a comparable rise in staff levels.

The challenge will not be a small one. Between 1999 and 2009, the number of U.S. gas wells rose by roughly 185,000. Most of the new wells involved HF. This growth trend is likely to continue.

The GWPC predicts that some states, faced with demands that they divert scarce resources to activities that they do not regard as cost-effective, might cede their regulatory primacy back to the EPA. In that case, the demands on EPA resources would escalate rapidly (Nickolaus 2007). Even without so dire an outcome, total state and federal resources would certainly be stretched thin. Unless funding keeps pace, both the quality of the permitting process and the growth of economic output would be bound to suffer.

Were the FRAC Act enacted, Congress might become more generous. Consider, though, that for the last thirty years, in current dollars, appropriations for the EPA's underground injection control program have remained essentially flat. By inference, in constant dollars, funding is, and long has been, in decline. In general, the EPA is not likely to prosper in an era of austerity. Even now, the White House funding request for EPA in FY 2013 involves a real-dollar decrease from FY 2012. Future spending is projected to continue falling (Esworthy et al. 2012).

"The concerns most often raised by supporters of the FRAC Act threaten to distract attention from issues that are, arguably, of greater moment. Already, media attention may be distorting the priorities of state-level regulatory efforts. Discussion of HF and methane contamination of well water and ground water dominates both media and scientific reports about shale gas development."

These funding problems reflect some basic features of U.S. environmental politics. EPA's mission is ideologically polarized. It has, therefore, become a point of sharp partisan conflict. As a result, when government is divided, the EPA is often buffeted from both ends of the political spectrum. And congressional Republicans have learned to use the appropriations process as a potent tool for reining in some of the EPA's more costly programs (Lazarus 2006). These facts suggest that the FRAC Act might clog the main artery of U.S. oil and gas production with the same kind of partisan and ideological blockage that now characterizes so much else in federal pollution policy.

Perhaps even more worrying, the FRAC Act threatens to unleash a torrent of litigation. If so, it would both retard operations and chill innovation. Currently, both state-level policy and the oil and gas industry itself are moving toward increased disclosure of the chemical constituents injected in HF. The FRAC Act, however, would take disclosure well beyond this level. The bills in Congress would mandate that the constituent chemicals used for HF must be disclosed to the EPA. The EPA would then post the chemicals on a public website. In cases of medical emergency, firms would be required to go beyond disclosing constituent materials. They would be required to provide exact chemical formulas. However, in this case, the Act would offer some protection against public disclosure of proprietary information.

On the one hand, more public information may indeed offer advantages in terms of better public sector risk assessment. On the other hand, it also raises a concern about the incentives for private sector innovation.

The incentive for the private-sector to conduct R&D depends importantly on its ability to protect proprietary information (Hirshleifer 1971). Indeed, private-sector innovation in the fluids used in fracturing was a key enabler of the current natural gas boom, and rapid innovation is continuing (Gény 2010). Additional R&D may in turn help to lower costs and to increase the scale of economically recoverable resources. Increased disclosure may, as a result, entail a sacrifice of dynamic efficiency in oil and gas drilling.

More troubling, though, is the likely interaction between the FRAC

Act's disclosure provisions and the citizen suits authorized under the SDWA.

… Section 1449 provides for citizen civil actions against any person or agency allegedly in violation of provisions of SDWA, or against the EPA Administrator for alleged failure to perform any action or duty that is not discretionary. This provision could represent an expansion in the ability of citizens to challenge state administration of oil and gas programs related to hydraulic fracturing and drinking water, were the hydraulic fracturing exemption provision to be repealed (Tiemann and Vann 2012).

Therefore, the bills' disclosure provision must be viewed in light of the new scope for citizen suits. The latter provisions, in effect, turn disclosure into a hunting license for any interest group seeking a pretext for litigation. To be sure, citizen suits may have the effect of supplementing the EPA's limited enforcement resources. Whether this effect should be regarded as a plus or a minus depends in part on whether, taking account of the environmental statute's strengths and weaknesses, greater enforcement of their provisions is a good thing or a bad one (Boyer and Meidinger 1985).

Furthermore, the process by which environmental groups select the suits they file is based on considerations largely unrelated to maximizing the larger public welfare. In practice, key goals involve attracting media coverage, pleasing major donors, recruiting members, raising revenue from penalties, and repaying attorneys' fees. The pattern of enforcement that arises from these mixed motives bears no necessary resemblance to that which would enhance social welfare—and may well detract from it (Seidenfeld and Nugent 2004).

The conflict may be especially acute in the case of shale gas development. Some major environmental groups have simply declared ideological war on the use of fossil fuels. The President of the Sierra Club has recently proclaimed:

Fossil fuels have no part in America's energy future – coal, oil, and natural gas are literally poisoning us. The emergence of natural gas as a significant part of our energy mix is particularly frightening because it dangerously postpones investment in clean energy at a time when we should be doubling down on wind, solar and energy efficiency (Sierra Club n.d.).

Given this stance, the linkage of the FRAC Act's disclosure and citizen suit provisions seems to portend unfettered legal obstructionism.

3.2. A Question of Regulatory Priorities

Thus, far from assuring the continued advance of the natural gas boom, the FRAC Act, in practice, entails high risk of snarling it in regulatory and legal gridlock. The risk is much more acute because resources are scarce. An obvious question is, given that scarcity, what issues merit priority treatment.

Today, both industry and regulators are grappling with a range of new challenges. The shale gas boom, for instance, often triggers classic "neighborhood effects" such as noise and highway congestion. Truck traffic and equipment used in shale gas development cause air emissions. Also, HF emits more methane than is common with conventional wells. Other concerns include various issues with chemical spills and pollution of surface water. HF has sparked some concerns about water supply, an issue that largely stems from western water rights that needlessly raise the costs of selling water to the highest bidder (Libecap 2011).

"... far from assuring the continued advance of the natural gas boom, the FRAC Act, in practice, entails high risk of snarling it in regulatory and legal gridlock."

The response has been a plethora of new regulatory schemes. The EPA under the Clean Air Act now limits shale gas-related emissions of volatile organic compounds (VOCs) and of methane. It has also put in place new standards on air emissions from various types of equipment used in oil and gas production. With water pollution, the EPA already has extensive control under the Clean Water Act (CWA). The agency requires a permit to discharge any pollutant into U.S. surface waters. It has established effluent limitation guidelines for oil and gas extraction. It has a program to control storm water discharges that is designed to limit erosion and sedimentation during construction. The EPA plans to propose CWA standards for the treatment of wastewater from shale gas wells in 2014. Since state agencies bear much of the enforcement burden, the new rules will stress their resources as well as those of the EPA itself.

As states grapple with this complex of regulatory issues, the concerns most often raised by supporters of the FRAC Act threaten to distract attention from issues that are, arguably, of greater moment. Already, media attention may be distorting the priorities of state-level regulatory efforts. Discussion of HF and methane contamination of well water and ground water dominates both media and scientific reports about shale gas development (Groat and Grimshaw 2012).

In fact, however, most of the environmental problems associated with current oil and gas development are not HF specific (The Royal Society and The Royal Academy of Engineering 2012). They relate to other phases of the process. The focus on the widely discussed HF-specific activities should not, therefore, be allowed to distract regulators or operators from the other phases of the process. Furthermore, as noted above, for HF itself "the highest risks from hydraulic fracturing may arise from surface spills of undiluted fracture fluid—not the fracturing process that occurs in the wellbore" (Groat and Grimshaw 2012). Yet oil and gas drillers already have strong incentives to avoid such spills. And existing federal and state regulations already cover them.

3.3. An Evolving Regulatory Regime

Under these circumstances, the prudence of adding a new layer of federal regulations addressed to underground issues is questionable. There are, however, tasks for which the federal government is clearly superior. Rather than duplicating state regulatory authority, federal policy might stress those tasks.

In contrast to what appears to be the case with the FRAC Act, some emission problems associated with oil and gas E&P are, of course, best handled on a national or even global level. For instance, greenhouse gas emissions known to contribute to climate change obviously entail cross-boundary effects. And natural gas wells are in the larger scheme of things a very minor source. In instances of that kind, controls should be comprehensive, uniform, and global in scope. More limited systems run the risk of causing second best problems.

For issues of narrower scope, the federal government might still play a useful role. It could, for instance, support ongoing efforts to improve the quality of state-level regulation. Public awareness of the natural gas boom has fanned widespread, and generally hostile, media coverage. State governments have strong political incentives to respond:

Various states have determined that the growing development of unconventional oil and gas resources, along with the increased use of hydraulic fracturing and directional drilling, requires more state oversight. Some states are responding by increasing staff resource levels. And in some states, including Colorado, North Dakota, New York, Ohio, Pennsylvania, Texas, West Virginia, and Wyoming, this expansion has prompted a reassessment and revision of oil and gas production regulations and policies. Common changes include new requirements for cementing, casing, pressure testing, and chemical disclosure. Colorado's rules, for example, include a well casing program to protect groundwater, require well treatment and fracturing reporting, and require operators to notify landowners at least one week before conducting various operations, including fracturing. A number of states, including Colorado and North Dakota, require baseline testing of nearby wells before drilling begins (Tiemann and Vann 2012).

Yet it is clear that much remains to be done. State regulators, therefore, have launched a series of cooperative ventures. These ventures bring together regulators, outside experts, environmental groups, and industry. They share expertise and experience in order to update assessments of best practices and to increase their adoption.

The Groundwater Protection Council (GWPC) is active in this effort. GWPC is a nonprofit corporation of state water quality regulators. It conducts reviews of state regulatory practices with regard to underground injection control programs. It also publishes reports and technical manuals on relevant subjects.

A second nonprofit corporation, State Review of Oil and Natural Gas Environmental Regulation (STRONGER) has formed under the GWPC aegis. STRONGER seeks to foster continuous improvement in regulatory processes. GWPC summarized these efforts in the following terms:

Periodic evaluations of state exploration and production waste management programs have proven useful in improving the effectiveness of those programs and increasing cooperation between federal and state regulatory agencies. To date, 18 states have been reviewed under the state review guidelines, and several have been reviewed more than once. [The number is now 22.] The STRONGER program has documented the effectiveness of and improvements in these state oil and gas environmental programs. The Interstate Oil and Gas Compact Commission (IOGCC) also completed state reviews using earlier versions of the guidelines prior to the formation of STRONGER (Ground Water Protection Council; ALL Consulting 2009).

In addition to its periodic state reviews, Stronger also monitors state responses to recommendations made in its reports. Stronger has established guidelines for regulation of HF operations covering structural features of wells, surface controls, reporting, staffing and training, public information, and water and waste management (Hydraulic Fracturing Workgroup, STRONGER 2010). Reviews continue to uncover potential improvements and to publicize new information (Kell 2011).

Some recent analysis by a federal advisory committee suggests that small federal investments in making existing regulatory authorities more cost-effective might be highly productive:

The Subcommittee has recommended that $5 million per year would provide the resources to STRONGER and the GWCPC needed to strengthen and broaden its activities as discussed in the Subcommittee's previous report, for example, updating hydraulic fracturing guidelines and well construction guidelines, and developing guidelines for water *supply, air emissions, and cumulative impacts. Additionally, DOE and/or EPA should consider making grants to those states that volunteer to have their regulations and practices peer-reviewed by STRONGER, as an incentive for states to undergo updated reviews and to implement recommended actions* (Shale Gas Production Subcommittee: Secretary of Energy Advisory Board 2011).

The federal government might also play a role in funding highly targeted R&D. In the past, U.S. DOE R&D funds have helped develop HF. And new technology might also ameliorate some of the current environmental concerns. Yet, even if regulation motivates for-profit firms to take steps to limit environmental harm, their inability to capture the social benefits of innovation limits the strength of the incentive to pay for R&D aimed at new, less polluting technologies (Montgomery and Smith 2007). Therefore, a sound public policy case exists for public sector funded R&D that seeks to lessen environmental side effects of oil and gas E&P (Gény 2010). Moreover, since no single state would be able to capture more than a fraction of the gains from R&D success, the task should logically fall to the federal government.

"The federal government might also play a role in funding highly targeted R&D."

4. Conclusion

In sum, developing U.S. natural gas resources will yield gains in economics, national security, and the environment. Yet extracting these resources also poses a number of environmental challenges. In response, the states and the federal government have assembled a regulatory regime. That regime is, at present, imperfect in many respects. Yet some progress is occurring especially at the state level. The FRAC Act would impose a new set of federal standards on state regulators. The above analysis implies that this step would not enhance the efficient division of labor between federal and state governments. It suggests as well that the federal government could play a more positive role by concentrating on regulatory issues where trans-border effects were strong. It could also help states become more efficient regulators and fund efforts to develop new technologies aimed at reducing the environmental costs of HF operations.

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