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The Shale Oil and Gas Revolution, Hydraulic Fracturing, and Water Contamination: A Regulatory Strategy

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The United States has surpassed Russia as the world's top natural gas producer and is on the threshold of overtaking Saudi Arabia as the largest oil producer. This "shale revolution" has created high-paying drilling jobs, revived the petrochemicals industry as well as other domestic manufacturing, improved our balance of payments, and increased the competitiveness of the United States in the global economy. By increasing the supply of oil and gas, fracturing has significantly reduced energy prices, enhancing consumer purchasing power and causing a more robust economic recovery. Fracturing has also reduced our reliance on energy imports and enhanced our energy security. In addition, the shale revolution has enabled the United States to reduce greenhouse gas emissions over the past several years—the largest reduction anywhere—by substituting natural gas for coal.

Fracturing is controversial. By reducing the price of natural gas, it may undercut the fledgling renewable energy industry, at least in the near term. The fracturing boom may also exacerbate air pollution, traffic, and congestion. The technology uses significant amounts of water, and some aspects of fracturing operations may induce tremors and minor earthquakes. In all these regards, fracturing is not unique, since each of these risks arises in conventional oil and gas drilling and, for that matter, in other economic activity as well.

The most unique risk associated with fracturing is potential groundwater contamination. The fluid used in fracturing contains toxic chemicals. In a sense, this risk is also not new. Although fracturing in shale has developed in the past decade, fracturing has been used in conventional drilling for over 60 years, so that two million wells have been "fracked" in the United States. There is little evidence so far that subterranean fracturing activity can directly contaminate groundwater. The layer of shale that is fractured is usually thousands of feet below the water table, with a buffer of dense rock or clay in between. But other risks to groundwater may prove to be more meaningful, including surface spills of fracturing fluid, improper handling of waste products, and the migration of natural gas into water wells. In response, we need effective regulation. Since fracturing in shale began fairly recently, the regime for dealing with some of these risks is not yet fully developed.

This Article considers how to regulate this risk of water contamination. The task entails a careful balance of competing considerations. The shale boom offers enormous benefits and should be encouraged. At the same time, we need regulation to ensure that it is safe, since water is a vitally important resource. In addition, the public must *believe* that shale drilling is safe. Otherwise, the shale revolution could be vulnerable to regulatory overkill, as media stories about flaming water faucets, brown well water, and sickly farm animals prompt widespread public apprehension about water contamination. In order to realize the potential benefits of fracturing, we need regulation that is carefully calibrated to minimize the real risks, without deterring socially valuable drilling. This challenge is all the more difficult because fracturing can potentially contaminate water in several ways. Some are well understood from decades of conventional oil and gas production and can be controlled with best practices regulations. Others are highly speculative, may or may not present real risks, and currently have no known solutions. As a result, regulatory responses should be dynamic, generating additional information about potential risks and stimulating innovations to reduce these risks.

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One element of our strategy is an evolving body of best practices regulations designed to reduce the risks of water contamination. To capture the advantages of best practices regulation while minimizing its disadvantages, we propose to backstop regulation with liability rules. Since determinations of causation are critical under any liability system, we recommend information-forcing rules to facilitate more accurate determinations of causation. To ensure that the regulatory regime is both dynamic and tailored to local conditions, we recommend keeping the regulatory center of gravity in the states, instead of fashioning a new federal regime.

I. Choosing a Regulatory Strategy for Water Contamination

The regulatory goal should be to support the shale revolution by steadily improving our understanding of the water contamination risks and working to reduce those risks. The best way to achieve this goal is by combining best practices regulation with liability for fracturing-related harms.

A. The Danger of Regulatory Overkill

We know that the prospect of groundwater contamination can motivate the public to support draconian regulatory measures. In the late 1970s, extensive publicity about toxic chemicals leaking into basements in Love Canal led Congress to enact the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).[1] Many commentators believe the cost of the response was disproportionate to the benefit.[2] It would be unfortunate if a similar dynamic were to stifle the shale revolution. The solution, we believe, is to adopt a sensible regime that reassures the public, motivates the industry to take appropriate precautions, and provides incentives to develop risk-reducing innovations over time.

B. Five Possible Regulatory Strategies

1. Prohibitions

One strategy for dealing with an environmental risk is simply to ban it. When the benefits are substantial and the risks are manageable, prohibition represents regulatory overkill. Prohibition also impedes innovation by limiting possibilities for experimentation in developing new ways to reduce the risk.

2. Command-and-Control Regulation

The oldest and most common form of command-and-control regulation mandates "best practices" to minimize external harms. This type of regulation typically requires all firms to adopt practices that reflect the "state of the art," meaning something more stringent than common practice that is still technologically and economically feasible. The familiar downside of command-and-control regulation is that it can yield inefficient regulations, since they are usually defined by the state of existing technology instead of rigorous assessment of costs and benefits. Regulated industry often prefers command-and-control regulation over other forms of regulation because it generates relatively predictable regulatory costs.

3. Disclosure

A third strategy requires the party primarily responsible for the external risk to disclose information about it. When forced to disclose risks, firms often make changes to eliminate or reduce them.[3] However, gathering and disseminating information can be costly, and information overload can be counterproductive.

4. Liability Rules

A fourth regulatory strategy levies monetary sanctions on firms that have imposed external harms on others. Common law tort liability is the most familiar example. Liability rules have two significant advantages. The first is deterrence. To avoid liability, actors have an incentive to reduce (or "internalize") harms they are likely to cause, especially if liability is imposed on the party with the best information and expertise to minimize risks efficiently. Second, liability provides compensation to those who suffer injury.

In practice, liability rules often are accompanied by uncertainty because they operate after the harm has occurred. For this reason, it can be difficult for firms to predict the costs of their actions, leading to over- or under-deterrence.

5. Coasean Bargains

A final strategy is to regulate external harms by contract.[4] For example, a driller could purchase both mineral rights and groundwater rights, and could agree to sell groundwater to the landowner at a specified price and quality. Coasean bargains nevertheless have significant limitations in this context. If fracturing threatens harm to parties

1. *See* Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§9601-9675 (2012).
2. *See, e.g.*, James T. Hamilton & W. Kip Viscusi, *The Magnitude and Policy Implications of Health Risks From Hazardous Waste Sites, in* Analyzing Superfund: Economics, Science and Law, 55, 78-81 (Richard L. Revesz & Richard B. Stewart eds., 1995).
3. *See* Paul R. Kleindorfer & Eric W. Orts, *Informational Regulation of Environmental Risks*, 18 Risk Analysis 155, 165 (1998).
4. *See* R.H. Coase, *The Problem of Social Cost*, 3 J.L. & Econ. 1 (1960).

not participating in a lease, contractual solutions become more difficult.

C. *Four Factors Influencing the Choice of Regulatory Strategy*

Is there any more systematic basis for choosing among regulatory strategies? A useful starting point is literature on ex ante versus ex post regulation. While ex ante regulation seeks to reduce harmful externalities *before* they occur, ex post regulation puts a price or sanction on harmful events *after* they occur, thereby creating an incentive to reduce their incidence. The focus of this literature is whether it is cheaper to determine optimal behavior before or after some discrete accident or other external harm has taken place.[5] In choosing between ex ante and ex post regulation, we should minimize the sum of ex ante and ex post costs by creating incentives for optimal behavior. Four factors illuminate sources of these costs: whether the sources of the harm are heterogeneous; whether the expected harm is high; whether settlement costs of allocating responsibility ex post are high; and whether the technology is novel.

D. *Applying These Factors to the Risk of Water Pollution From Fracturing*

1. Heterogeneity of Risk

In controlling water pollution from fracturing, some sources of the risk are homogeneous while others are heterogeneous. Virtually *all* oil and gas production poses the risk of blowouts,[6] leaks from vertical drill pipes into aquifers, and improper disposal of drilling waste and produced water.[7] Best practices regulations are appropriate for this sort of issue.

For heterogeneous risks, such as the risk of fracturing fluid or methane escaping from target shale beds and migrating to aquifers, there is no one technology that can address these risks in a uniform way.[8] Some form of ex post regulation is needed, at least for now.

2. Magnitude of Expected Harms

The second factor, the frequency and severity of the harm, also varies with the pathway of contamination. Activities that present an obvious risk of significant harm if not controlled are either already regulated by best practices regulations, or if not, they should be.

Other risks appear to be more remote. With fracturing fluid, for instance, alleviating uncertainty is a good reason to require disclosure of chemicals used in fracturing.

Still another factor is whether the harm will be limited to property damage or will involve health effects. If contamination is detected early, injuries should be primarily economic: the primary consequence should be a decline in property values. But if the harm is not detected early, there could be health effects that are significantly more costly.

3. Settlement Costs

A critical variable is whether the amount of injury per claimant is sufficiently large to warrant individualized assessments. If water contamination is quickly detected and results in avoidance measures that prevent significant harm, the potential damages might be too small to sustain a liability regime. Also, if significant time has elapsed between fracturing and the discovery of contamination, identifying a defendant sufficiently solvent to pay damages may be difficult. These considerations provide a reason to rely, at least in significant part, on command-and-control regulation rather than a pure liability regime.

4. Novelty of Risk

Ex ante regulation is more challenging with a novel technology because there is no baseline of existing precautions to define the "best practices" regulatory standard. With new technology there is thus a strong reason to rely at least in part on ex post regulation. Insofar as fracturing in shale presents water contamination risks identical to those in conventional oil and gas production—such as disposing of produced water, minimizing well casing leaks, and controlling blowouts—the risks and potential solutions are familiar, so this experience can support ex ante best practices regulation.

However, ex ante regulation is much more difficult for pathways of contamination that are novel to fracturing. For now, there is insufficient understanding of the frequency and magnitude of these risks, as well as how to minimize them, to support a system of ex ante regulation.

E. *The Regulatory Strategy for Water Contamination From Fracturing*

We are now in a position to draw these considerations together and propose in broad outline a regulatory strategy.

1. The Need for Both Best Practices Regulation and Liability

As a core element of our regulatory strategy, best practices regulation offers three advantages. First, it is especially well-suited to risks that are either common to all forms of oil and gas production or are familiar from other types of industrial operations. Second, the idea that a public regula-

5. *See* Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 Duke L.J. 557, 572 (1992).
6. Blowouts are "gushers" or the uncontrolled release of gas or oil.
7. Produced water is briny water from deep below the earth's surface that comes up with the oil or gas during the drilling process.
8. *See* Sec'y of Energy Advisory Bd., Shale Gas Production Subcommittee 90-Day Report 8, 10 (2011), *available at* http://energy.gov/sites/prod/files/Final_90_day_Report.pdf.

tory body is "on the case" is reassuring to the public. Third, because energy companies must make substantial investments to drill in shale, they need to estimate what regulatory costs they will face. Best practices regulation offers this predictability.

However, best practices regulation has three important drawbacks, so that it must be backstopped by liability. First, best practices regulation is only as effective as the resources committed to enforcing it. Second, best practices regulation is ineffective for heterogeneous or novel risks. Third, command-and-control regulation provides relatively poor incentives to develop new risk-minimizing innovations. Liability rules provide a much more powerful incentive in this regard.

2. Three Rules to Coordinate Liability With Best Practices Regulation

Best practices regulation and liability should be coordinated, so that liability standards vary depending on whether a best practices regulation governs the conduct that caused the contamination. Specifically, we envision three different liability rules depending on compliance with best practices regulations.

First, any water contamination causally attributable to the violation of a best practices regulation should be considered negligence per se and should result in liability.

Second, any claim that water contamination was caused by the failure of an energy company to adopt a measure *more* protective than required by an applicable best practices regulation should generally be defeated by a regulatory compliance defense. These two per se rules create a powerful incentive for industry to support the development of protective best practices rules and to comply with them.

The third rule fills any gaps left by the first and second: if the water contamination is causally attributable to the defendant's fracturing, but cannot be linked to an activity governed by a best practices rule, we would apply a version of the doctrine of res ipsa loquitur. In such a regulatory vacuum, proof that the energy company caused the contamination would create an inference that the firm was negligent, shifting the burden to the company to prove it exercised reasonable care. The standard of care, as a practical matter, would approach strict liability. This rule would give energy companies a strong incentive to learn how to reduce the residual risks not governed by best practices regulations and to help regulators develop new best practices regulations.

3. The Supporting Role of Prohibitions, Disclosure, and Coasean Bargains

Although we would not rely on prohibitions as the principal strategy, they are appropriate where risks are especially great. Information disclosure would also play an important, if secondary, role. Blowouts and leaks should be disclosed, as well as the chemicals used in fracturing fluid.

We also view Coasean bargains as an appropriate regulatory strategy. The problem is that *neither* the energy companies nor the landowners have definitive information about the nature and magnitude of the risks. We therefore expect at least some parties to be reluctant to allocate these risks by contract.

II. Designing a Regulatory Regime for Water Contamination

In this part, we offer more detail about our proposed regulatory regime, focusing on design of the liability rule and its interaction with best practices regulation.

A. Causation

1. Contamination Injury

For energy companies to have the right incentives, they should be liable only if they *actually cause* harm. Thus, plaintiffs should be required to prove by a preponderance of the evidence that fracturing was a but-for cause of water contamination on their property.

This showing is challenging for three reasons. First, if the plaintiff's water well contains an unusual chemical, how do we know it comes from fracturing, as opposed to a natural cause or some other sources of pollution? Second, if several energy companies are fracturing in a given locale, how do we know which one is responsible? Third, what if contamination is discovered years after energy companies have stopped fracturing in a particular locale? These questions are difficult because the parties have only limited information.

To address these questions, the liability regime should create incentives to develop better information. We suggest three ways to pursue this "information forcing" goal,[9] ranked in order of importance: baseline testing; disclosure; and tracer chemicals.

a. Baseline Testing

The most important step is to test groundwater before fracturing begins in order to establish a benchmark of water quality. If an allegation of contamination is made, the water would be tested again. If contaminants are found that were not present in the baseline sample, this would support the allegation that fracturing caused the contamination. Conversely, if the contaminants were already there, this would powerfully rebut such a claim.

Baseline testing cannot be conducted if landowners do not allow access to their water wells. They might be motivated by a desire for privacy or, for that matter, by a concern that any negative information they learn would have to be disclosed when they sell their property. Whatever

9. *See, e.g.*, Bradley C. Karkkainen, *Information-Forcing Environmental Regulation,* 33 Fla St. U. L. Rev. 861 (2006).

their reasons, if landowners refuse to consent to a baseline test, they should pay a price for doing so. We would require them to overcome a presumption that the drilling activity did not cause the contamination.

b. Disclosure of Fracturing Chemicals

We should also require disclosure of all chemicals used in fracturing fluid, a step voluntarily taken by many companies and now required in a number of states.[10] When paired with baseline testing, disclosure can make determinations of causation more accurate.

The primary objection to disclosure is that the composition of each energy company's fracturing fluid is a trade secret. However, the trade secret would not necessarily be compromised if companies were required to disclose only the ingredients in their fluid, but not the quantities or proportions used.[11]

c. Tracer Chemicals

A third information forcing strategy would require energy companies to include tracer chemicals in their fracturing fluid.[12] Each energy company would include a unique but harmless and nondegradable chemical in their fracturing fluid, and would register it with the relevant regulator. If water contamination is alleged, the water would be tested for this chemical marker. If it is found, the energy company's fracturing fluid probably caused the contamination; if not, it presumably did not.

2. Pathways of Causation

Once the plaintiff establishes that fracturing activity caused the contamination, the next issue concerns *how* the water was contaminated and whether the pathway of contamination was governed by best practices regulations. We would apply different liability rules depending on whether the pathway is governed by regulations.

We suspect that direct proof of the pathway of contamination will be possible only in a subset of cases. We would allow either party to introduce such evidence. In many cases, the evidence will not reveal exactly how the water was contaminated, and thus whether a best practices regulation addressed the relevant conduct in the case. In these circumstances, if the plaintiff proves both (1) that fracturing caused the contamination, and (2) that the energy company violated a regulation governing a particular pathway of contamination, we would create a presumption that this was the pathway of contamination.[13]

3. The Scope of the Harm

In nearly all cases, the contamination will have caused property damage. Contamination that goes undetected for some time might also have caused more serious injuries.

The best we can do may be to establish additional presumptions. Specifically, (1) if an energy company has increased the concentration of a chemical in a water well; (2) the concentration exceeds the applicable maximum contaminant levels under the Safe Drinking Water Act; (3) the landowner has been exposed to the water for an appreciable period of time (e.g., at least one year); and (4) the landowner has experienced an injury associated by the U.S. Environmental Protection Agency (EPA) with exposure to the chemical, then a presumption would arise that exposure to the chemical caused the injury. The burden would shift to the energy company to rebut the presumption.

B. Standard of Care

Once issues of causation are resolved, it is necessary to specify the standard of care we will use to evaluate the energy company's conduct. Most discussions assume there are two options: strict liability and negligence.

We recommend a hybrid approach that, in form, is based on negligence, but as a practical matter would function like strict liability in many circumstances. Specifically, we recommend adopting a negligence framework requiring energy companies to conform to a standard of reasonable care that would be defined in significant part by best practices regulations.

Thus, we would apply three different standards of care depending on the circumstances: First, violation of best practices regulations would establish negligence per se (which functionally resembles strict liability). Second, compliance with best practices regulations would establish a (qualified) regulatory compliance defense. Third, if no best practice regulations govern the problem leading to the contamination—or, relatedly, if it is impossible to identify how the contamination occurred—we would apply the doctrine of res ipsa loquitur, which would, for practical purposes, function much like strict liability.

C. Plaintiff Fault and Releases From Liability

We do not expect plaintiff fault to be an issue in the typical water contamination case, where the energy company is active and the landowner is passive. But the issue could arise in some cases. In this sort of case, energy companies should be allowed to raise the plaintiff's comparative negligence as a defense. Liability should be apportioned between

10. *See* Kate Galbraith, *Seeking Disclosure on Fracking*, N.Y. Times (May 30, 2012), http://www.nytimes.com/2012/05/31/business/energy-environment/seeking-disclosure-on-fracking.html?_r=0.
11. *See* Sara Dastgheib-Vinarov, *A Higher Nonobviousness Standard for Gene Patents: Protecting Biomedical Research From the Big Chill*, 4 Marq. Intell. Prop. L. Rev. 143, 151-53 (2000).
12. *See* Chris Mooney, *The Truth About Fracking*, 305 Sci. Am. 80, 80-85 (2011).
13. This is analogous to what Ken Abraham calls "self-proving causation," Kenneth S. Abraham, *Self-Proving Causation* (Univ. of Va. Law Sch. Research Paper Series, Sept. 2013), *available at* http://ssrn.com/abstract=2320596.

the plaintiff and the defendant based on how much each contributed to the contamination.[14]

In some cases, we would also recognize a defense of assumption of the risk. In theory, one could hold that the plaintiff assumed the risk simply by signing a mineral lease, with the expectation of sharing in oil and gas revenues. If a plaintiff has signed a lease that includes a written and prominently disclosed release of liability for water contamination, we would respect the release.

D. *Measure of Damages*

Any harm incurred by the plaintiff should be measured accurately. A key element of harm will be damage to the land, which ordinarily is measured by the decline in the land's fair market value. A partial solution is to let the plaintiff choose to recover the cost of restoring access to potable water.

Damages for any health effects will also have to be calculated. This sort of damages is familiar in other types of litigation.

We believe punitive damages would be appropriate for defendants who falsify reporting requirements or knowingly violate regulations insuring well integrity or preventing surface spills. However, we would preclude the award of punitive damages for defendants who are in full compliance with all best practices regulations and disclosure requirements, engage in periodic testing, and are free of any affirmative misconduct. This safe harbor rule would give energy companies an added incentive to comply with these safety-promoting rules.

E. *Insolvency Risk*

If insolvency turns out to be a problem, a mixed liability/government insurance regime may be needed. Any energy company that engages in fracturing could be required to contribute to a general insurance fund, which would cover the damages if the responsible energy company is insolvent. If the fund is exhausted, taxpayers would make up the difference. To mitigate moral hazard, firms should be charged experience-based fees, so that those with a record of accidents have to pay more.

III. Implementation Options

We now turn to the separate questions of which level of government should implement this regime, and which branch of government should do so. Institutions that have regulated issues in the past will have a presumptive claim to do so in the future, based on their expertise, relationships with important interest groups, and natural inclination to protect their turf.

A. *Jurisdictional Scope*

Currently, states have principal regulatory responsibility over oil and gas production as well as groundwater. As a result, every state where fracturing is taking place has an oil and gas commission.[15] In contrast, the federal government has played almost no role in regulating oil and gas production on private land.[16]

A regulatory jurisdiction generally should correspond to the geographic scope of the externality, sometimes known as the "matching principle."[17] Thus, the federal government should regulate interstate pollution, the states should regulate spillovers confined to a single state, and localities should regulate externalities with local effects. This assures that the regulator considers all costs and benefits of the activity without ignoring those borne by outsiders, while simultaneously preserving flexibility to account for local conditions.

Economies of scale in regulation are also important.[18] The best justification for the federal role in regulating local public drinking water systems is the technical expertise required, although actual enforcement remains with the states. In regulating fracturing, then, EPA would need to build out its expertise substantially. Federal regulation also tends to be ponderously slow, perhaps in part because the stakes are higher and consequently more interest groups get involved.[19] While the states have fewer resources overall, they have a significant head start in regulating oil and gas, and to a lesser extent, groundwater.

Arguably, the geographic scope of the externality favors localities, although uncertainties about the scope of contamination would perhaps warrant centering regulation in a body having a larger jurisdictional scope, like the states. Economies of scale favor the federal government. The states are a viable compromise on both dimensions, since they are closer to the externality than the federal government and have greater expertise and resources than local governments. Therefore, it is certainly reasonable—and arguably preferable—for states to take the lead in regulating the risk of water contamination from fracturing, at least for now.

B. *Implementing Body*

Every state in which fracturing is taking place or is contemplated has a functioning regulatory commission. Although they have varying degrees of discretionary authority to

14. To be clear, we do not recommend contributory negligence, which affords a complete defense to liability, since this might undercut defendants' incentives to take precautions.

15. *Cf.* Thomas E. Kurth et al., *American Law and Jurisprudence of Fracing–2012*, 58 Rocky Mountain Min. L. Found. 1, 65-154, *available at* http://www.haynesboone.com/american-law-and-jurisprudence-on-fracing-2012/.

16. *See* David B. Spence, *Federalism, Regulatory Lags, and the Political Economy of Energy Production*, 161 U. Pa. L. Rev. 431, 477 (2013).

17. *See* Henry N. Butler & Jonathan R. Macey, *Externalities and the Matching Principle: The Case for Reallocating Environmental Regulatory Authority*, 14 Yale L. & Pol'y Rev. 23, 25 (1996).

18. *See* Richard B. Stewart, *Pyramids of Sacrifice? Problems of Federalism in Mandating State Implementation of National Environmental Policy*, 86 Yale L.J. 1196, 1212 (1977).

19. *Cf.* Christopher S. Kulander, *Shale Oil and Gas State Regulatory Issues and Trends*, 63 Case W. Res. L. Rev. 1001, 1141 (2013).

adopt new regulations, all have at least some authority in matters of well construction, spacing, and safety. We assume, therefore, that state commissions with current regulatory authority over oil and gas production are the place to start.

Legislation may be needed to augment their authority. As previously discussed, regulators should be empowered to require baseline testing of water quality and to compel public disclosure of chemicals used in fracturing. In addition, commissions should be authorized to adopt best practices regulations.

A further question is who should implement the liability regime that we propose. There is much to be said for using an administrative tribunal. But at this point it is not clear that fracturing will generate water contamination at a scale that will require the adjudication of very many disputes.

Fortunately, if courts must adjudicate water contamination claims, we have an off-the-rack liability regime: the common law of torts. Admittedly, tort does not have all the features we would ideally like to see in an ex post liability regime, such as insolvency protections. Nevertheless, it is sufficiently flexible to replicate many aspects of this proposal. In addition to its capacity to accommodate our proposal, the common law has the added virtue of already addressing any issue that a liability regime is likely to face, including defenses based on plaintiff misconduct, joint and several liability, the measure of damages, and the enforcement of judgments.

IV. Conclusion

Fracturing is transforming the energy landscape of the United States. By unlocking massive reserves of natural gas and oil in shale beds and other tight rocks, fracturing is creating drilling jobs, fueling a revival of domestic manufacturing, strengthening consumer purchasing power, improving our balance of payments, enhancing our energy independence, and reducing U.S. greenhouse gas emissions.

Yet at the same time, fracturing poses a number of risks. Some arise in conventional oil and gas drilling as well as in other economic activities, such as competition with renewable energy, traffic and congestion, air pollution, the use of significant amounts of water, and the risk of inducing earthquakes. Fracturing also poses unique risks of water contamination, which are the focus of this Article. Although there is only limited evidence of water contamination from fracturing so far, the risks are not yet fully understood and mechanisms for regulating them are not yet fully developed. We offer a general framework for regulating in the face of uncertainty and apply it to water contamination for fracturing.

A core element of our proposal is best practices regulation. We can encourage the development of a robust practices regime by backstopping it with liability. Under our proposed liability regime, unless an energy company is in full compliance with applicable best practices regulations, it generally would have to pay for any water contamination harms caused by fracturing operations. In addition, we believe our proposed regime should be implemented at the state level. A realistic option, at least in the near term, is to adapt the existing common law of torts to the unique problems posed by fracturing. This blended strategy can perform the vital function of protecting our water resources, while also harnessing the substantial economic, national security, and environmental advantages of the shale oil and gas revolution.