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Responsible Shale Gas Productions: Moral Outrage vs. Cool Analysis

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Abstract

The relatively sudden boom in shale gas production in the United States using hydraulic fracturing has provoked increasingly intense political conflict. The debate over fracking and shale gas production has become polarized very quickly, in part because of the size of the economic and environmental stakes. This polarized debate fits a familiar template in American environmental law, pitting "cool analysis" against "moral outrage." Opponents of fracking have generally framed their arguments in moral or ethical terms, while systematic research is beginning to build a more careful and nuanced understanding of the risks associated with shale gas production (though the record is far from complete). All of which makes the question of how to produce shale gas "responsibly" – corporate social responsibility being the focus of this symposium – very difficult to answer. This essay argues that: (i) because shale gas production entails difficult to measure and unevenly distributed costs and benefits, there is no clear responsible (read: ethically preferable) set of limitations that we ought to impose on shale gas production; and (ii) moral outrage is obscuring (or influencing perceptions of) empirical facts in the shale gas policy debate. More specifically, well-established behavioral heuristics – particularly, confirmation biases and the cultural cognition of risk – are impeding the development of a common understanding of the empirical facts necessary to guide policymaking. Recognizing this, policymakers must resist political pressures and work that much harder to ground their decisions in empirically-demonstrated facts – namely, those produced by sources that are less susceptible to these heuristics and biases. Thus, information generated by rigorous, empirical analyses performed by academic or government sources ought to be credited over anecdotes or studies associated with industry or NGOs that have staked out a clear pro or con position in the fracking debate. Indeed, responsible fracking decisions ought to consider all of the consequences of permitting, regulating or banning shale gas production, including the relative risks of shale gas production compared with the relevant energy alternatives.

KEYWORDS: hydraulic fracturing, fracking, shale gas production

RESPONSIBLE SHALE GAS PRODUCTION: MORAL OUTRAGE VS. COOL ANALYSIS

David B. Spence[*]

As long as the connection subsists between [man's] reason and his self-love, his opinions and his passions will have a reciprocal influence on each other.
— James Madison[1]

INTRODUCTION

American energy policy has been transformed in recent years by the increased production of natural gas from formerly inaccessible shale formations using hydraulic fracturing[2] (also known as fracking). The United States has become the world leader in natural gas production[3] after only recently facing the prospect of having to rely on natural gas imports.[4] However, shale gas production has

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1. THE FEDERALIST NO. 10 (James Madison).

2. For description of this production technique, see *infra* Part I.

3. *The U.S. Surpassed Russia as World's Leading Producer of Dry Natural Gas in 2009 and 2010*, U.S. ENERGY INFO. ADMIN. (Mar. 13, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=5370.

4. *See* Howard Rogers, *Shale Gas—The Unfolding Story*, 27 OXFORD REV. OF ECON. POL'Y 117, 118 (2011):

> As we entered the 2000s the prevailing view of gas as a cheap and plentiful energy source changed to one of concern over the ability of gas supplies to keep pace with future rising demand, particularly in the power generation sector. In North America, in 2001 domestic

generated opposition—indeed, an opposition *movement*—focused on the environmental externalities[5] posed by fracking. Those externalities include truck traffic, noise, social and economic disruption, and increased risks (the magnitude of which is disputed) of groundwater contamination, seismic activity, and air pollution. At the same time, shale gas production brings significant economic benefits in the form of lower energy prices,[6] jobs in shale gas production areas,[7] and increased investment in industries for which

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production began a pronounced decline and large-scale liquefied natural gas (LNG) imports appeared inevitable by 2010.

5. The term "externality" refers to costs of production that are not borne by the firm, but rather are shifted to society. Externalities can be either negative or positive. For a discussion of the economics of negative externalities, see TOM TIETENBERG, ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS, 52–54 (3d ed. 1992). For a discussion of the externalities of shale gas production, see *infra* Part I.B.

6. Gas prices have fallen from more than $10 per thousand cubic feet (Mcf) a decade ago to less than $4/Mcf today. *See* U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2012 WITH PROJECTIONS TO 2035, at 36 (2012), http://www.eia.gov/forecasts/archive/aeo12/pdf/0383(2012).pdf (describing production increase); U.S. Energy Info. Admin., *Selected Average Natural Gas Prices, 2007-2012*, NATURAL GAS MONTHLY, Feb. 2013, http://www.eia.gov/naturalgas/monthly/archive/2013/2013_02/pdf/table_03.pdf (describing price declines). One way to predict future natural gas prices is to look at so-called "forward curves" produced by the New York Mercantile Exchange ("NYMEX"). These curves are based upon prices of futures contracts—contracts for the sale of natural gas at various points in the future. The current NYMEX forward curve for natural gas projects that prices will remain at or below five dollars per million Btu ("MMBtu") over the next five years. *See Gas Futures Trading: Forward Price Curve*, Fed. Energy Reg. Comm'n (last updated Oct. 10, 2013), http://www.ferc.gov/market-oversight/mkt-gas/trading/ngas-tr-fwd-pr.pdf.

7. *See Economics of the Bakken Oil Boom: What the Rest of the Nation is Missing*, INST. FOR ENERGY RES., (Jan. 8, 2013), http://instituteforenergyresearch.org/2013/01/08/economics-of-the-bakken-oil-boom-what-the-rest-of-the-nation-is-missing (detailing low unemployment and other economic benefits in the Bakken Shale region); Robert T. Garrett, *South Texas Drilling Boom Shakes Loose Dollars for State Budget Writers*, THE DALL. MORNING NEWS (Jan. 7, 2013, 10:48 PM), http://www.dallasnews.com/news/politics/texas-legislature/headlines/20130107-south-texas-drilling-boom-shakes-loose-dollars-for-state-budget-writers.ece?action=reregister (detailing the budgetary and other economic benefits of the shale gas boom in the Eagle Ford Shale region); Mark Lisheron, *Booming Revenues Have Officials in Texas Pondering Pay Raises, Boosts to Programs*,

natural gas is an important input.[8] It also produces environmental benefits (the magnitude of which are also disputed) by facilitating the substitution of natural gas for coal in the American energy mix.[9]

All of which has made shale gas production the focus of increasingly intense political conflict. It is the industry's job to develop energy resources responsibly and the government's job to regulate shale gas production. However, the debate over fracking and shale gas production has become polarized very quickly, in part because of the size of the economic and environmental stakes. In recent years, some nations (France,[10] South Africa[11]), several U.S. states,[12] and many local communities[13] have imposed permanent or

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TEXAS WATCHDOG (Jan. 9, 2013, 10:53 AM), http://www.texaswatchdog.org/2013/01/booming-revenues-have-officials-in-texas-pondering-pay/1357749744.column (chronicling increases in state tax revenues attributable to shale gas development).

8. *See, e.g.*, Kevin Bullis, *Shale Gas Will Fuel a U.S. Manufacturing Boom*, MIT TECH. REV. (Jan. 9, 2013), http://www.technologyreview.com/news/509291/shale-gas-will-fuel-a-us-manufacturing-boom (ascribing increased investment in manufacturing in the United States to low natural gas prices); *Shale Gas Fuels U.S. Manufacturing Renaissance*, BUS. WIRE (Jan. 10, 2013, 11:18 AM), http://www.businesswire.com/news/home/20130110005889/en/Shale-Gas-Fuels-U.S.-Manufacturing-Renaissance (describing ExxonMobil's projections of increased U.S. investment in chemicals manufacturing due to low gas prices).

9. For a fuller discussion of these benefits, see *infra* Part III.

10. Tara Patel, *France to Keep Fracking Ban to Protect Environment, Sarkozy Says*, BLOOMBERG (Oct. 4, 2011, 10:21 AM), http://www.bloomberg.com/news/2011-10-04/france-to-press-ahead-with-shale-research-after-fracking-ban.html ("France will maintain a ban on fracking until there is proof that shale gas exploration won't harm the environment or 'massacre' the landscape, President Nicolas Sarkozy said.").

11. Steve Hargreaves, *The Fracking Public Relations Mess*, CNN MONEY (June 21, 2011, 11:16 AM), http://money.cnn.com/2011/06/21/news/economy/fracking_public_relations/index.htm ("When Maryland Governor Martin O'Malley issued an executive order banning fracking earlier this month, the state joined the ranks of New York, Quebec, Germany, France and South Africa to halt the controversial technique for extracting natural gas from shale rock.").

12. The state of Vermont has banned fracking. *Vermont Fracking Ban: Green Mountain State Is First In U.S. To Restrict Gas Drilling Technique*, ASSOCIATED PRESS, May 16, 2012, *available at* http://www.huffingtonpost.com/2012/05/17/vermont-fracking-ban-first_n_1522098.html (describing the Vermont ban as largely symbolic, since Vermont has few shale gas resources). New York has imposed a moratorium on certain kinds of hydraulic fracturing pending further study of the problem. The New York ban was created by executive order of the governor, N.Y. Exec. Order No. 41 (Dec. 13, 2010), requiring further

temporary bans on fracking. These bans and moratoria reflect the intensity with which some people have opposed fracking operations on environmental, health and safety grounds.[14] In many ways, this public policy debate over hydraulic fracturing fits a familiar template in American environmental law, the duality of which Christopher Schroeder once described as "cool analysis" versus "moral outrage."[15] Opponents of fracking have generally framed their

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environmental of high-volume fracking in the Marcellus shale, following his veto of state legislation imposing a much broader ban. *See* S. 8129-B, 2010 Leg., 233d Reg. Sess. (N.Y. 2010). Bills have been introduced into the New Jersey and Maryland legislatures to impose moratoria on fracking there, though the governors of both states have already imposed moratoria pending further study. *See* Assemb. 3644, 215th Leg. (N.J. 2013), *available at* http://legiscan.com/NJ/text/A3644/id/678194 (text of the proposed New Jersey legislation); *Del. Shane Robinson and Sen. Karen Montgomery Introduce Statewide Ban on Fracking*, FOOD & WATER WATCH (Jan. 24, 2013), http://www.foodandwaterwatch.org/pressreleases/del-shane-robinson-and-sen-karen-montgomery-introduce-statewide-ban-on-fracking (describing the new bills introduced into the Maryland legislature); Tom Johnson, *Fracking Ban Doesn't Go Far Enough for Environmentalists*, NJ SPOTLIGHT (Feb. 4, 2013), http://www.njspotlight.com/stories/13/02/03/fracking-ban-doesn-t-go-far-enough-for-environmentalists (describing the New Jersey legislation and the governor's moratorium); Timothy B. Wheeler, *O'Malley Panel Urges Fracking Safeguards*, THE BALTIMORE SUN (Jan. 7, 2013), *available at* http://articles.baltimoresun.com/2013-01-07/features/bs-gr-fracking-legislation-20130107_1_severance-tax-sand-and-chemicals-shale-gas-extraction (describing the situation in Maryland).

13. Hargreaves, *supra* note 11.

14. *See* John Kemp, *Making Fracking Politically Acceptable*, REUTERS (Feb. 6, 2012), http://www.reuters.com/article/2012/02/06/column-fracking-politics-idUSL5E8D62Q920120206; Mireya Navarro, *Judge's Ruling Complicates Hydrofracking Issue in New York*, N.Y. TIMES (Feb. 22, 2012), http://www.nytimes.com/2012/02/23/nyregion/judges-ruling-complicates-hydrofracking-issue-in-new-york.html; Jim Polsen, *New Yorkers Split on Marcellus Shale Gas Drilling, Survey Finds*, BLOOMBERG (Sept. 21, 2011, 6:00 AM), http://www.bloomberg.com/news/2011-09-21/new-yorkers-split-on-marcellus-shale-gas-drilling-survey-finds.html.

15. Christopher H. Schroeder, *Cool Analysis Versus Moral Outrage in the Development of Federal Environmental Criminal Law*, 35 WM. & MARY L. REV. 251 (1993). Economist Anthony Downs earlier described a related pattern in environmental law, which he called "the issue attention cycle." *See* Anthony Downs, *Up and Down with Ecology—The "Issue Attention Cycle"*, 28 PUB. INT. 38 (1972). For a more general discussion of the role of morality in the history of environmental law, see David B. Spence, *Paradox Lost: Logic, Morality, and the*

arguments in moral or ethical terms, calling shale gas production a "nightmare"[16] that will harm people and the environment. The industry's proponents point to the paucity of hard data supporting opponents' claims, dispute the anecdotal evidence opponents cite, and respond with their own exaggerated claims. Meanwhile, systematic research is beginning to build our understanding of the risks associated with shale gas production, though the record is far from complete.

This makes the question of how to produce shale gas "responsibly"—as corporate social responsibility was the focus of this symposium—very difficult to answer. This essay will explore the role of moral outrage and cool analysis in the debate over how to produce shale gas responsibly. Its basic thesis is that: (i) we ought not to assess the risks of shale gas production in a vacuum, but rather ought to base regulatory decisions on the *relative* risks of shale gas production; and (ii) moral outrage is obscuring (or influencing perceptions of) empirical facts in the shale gas policy debate. Part I of this essay explains the foundations of the fracking debate, including the process of producing natural gas from shale formations using hydraulic fracturing. This section briefly summarizes what we know (and do not know) about its impacts. Part II will explore the concept of "responsible development," and the behavioral questions surrounding any normative assessment of this form of energy production. Part II.A will argue that any normative analysis of fracking (or fracking regulation) must be based upon the identification and measurement of the impacts of shale gas production, a matter over which combatants in the fracking debate cannot agree. Part II.B examines the behavioral dimensions of the fracking debate, and argues that well-established behavioral heuristics—particularly, confirmation biases and the cultural cognition of risk—can impede the development of a common understanding of the empirical facts necessary to guide policymaking. The concluding section, Part III, argues for policies based upon empirically-demonstrated facts—namely, those produced

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Foundations of Environmental Law in the 21st Century, 20 COLUM. J. ENVTL. L. 145, 168–71 (1995).

16. The term "nightmare" is routinely used by anti-fracking activists and others to describe the effects of fracking. A Google search of the term "fracking nightmare" on February 7, 2013 produced 744,000 results.

by sources that are less susceptible to the heuristics and biases outlined in Part II. Thus, information generated by rigorous, empirical analyses performed by academic or government sources ought to be credited over anecdotes or studies associated with industry or NGOs that have staked out a clear pro or con position in the fracking debate.

I. MORAL OUTRAGE, COOL ANALYSIS, AND SHALE GAS PRODUCTION

It will come as no surprise to those familiar with the history of American environmental policy that the shale gas policy debate is infused with a healthy dose of moral outrage, while cool analysis of the issues is mostly relegated to government and academic circles. Appeals to morality and ethics can mobilize public attention to important issues[17] and have featured prominently in American environmental policy history.[18] Indeed, the major environmental legislation of the 1970s might not have been possible but for the ability of environmental groups and other political entrepreneurs to mobilize the American public using appeals based upon the risk of harm caused by industrial activity.[19] Like their predecessor activists in the environmental movement, opponents of shale gas production often frame their objections in normative ethical terms, focusing on the harm shale gas production might do, on producers' alleged indifference to that harm,[20] and on locals' right to be free from that

17. *See* Downs, *supra* note 15 (describing how groundswells of public attention can galvanize political support for environmental initiatives).

18. *Id.*

19. For further development of this idea, see James Gray Pope, *Republican Moments: The Role of Direct Popular Power in the American Constitutional Order*, 139 U. PA. L. REV. 287 (1990); *see also* Daniel A. Farber, *Politics and Procedure in Environmental Law*, 8 J.L. ECON. & ORG. 59, 60 (1992); David B. Spence, *A Public Choice Progressivism, Continued*, 87 CORNELL L. REV. 397, 423–26 (2002).

20. *See, e.g.*, Alison Rose Levy, *4 Horrifying Dangers of Fracking*, ALTERNET (Nov. 30, 2012), http://www.alternet.org/fracking/4-horrifying-dangers-fracking; Sara Jerving, *Fracking Exposed: Shocking New Report Links Drilling With Breast Cancer and Women's Violence*, POLICYMIC (Apr. 4, 2012), http://www.policymic.com/articles/6465/fracking-exposed-shocking-new-report-links-drilling-with-breast-cancer-and-women-s-violence. *See also* Sean Lennon, *Destroying Precious Land for Gas*, N.Y. TIMES (Aug. 27, 2012), http://www.nytimes.com/2012/08/28/

harm.[21] Proponents of fracking have focused mostly on refuting charges that fracking leads to environmental harm, and on touting the economic benefits of shale gas production.[22] Because shale gas production is a young industry, we are still learning about its effects, effects which the combatants in the fracking debate dispute. Therefore, it is important at the outset to separate the disputed from the undisputed facts about fracking.

A. The Undisputed Effects of Fracking

Conventional natural gas production involves the drilling of wells into permeable or semi-permeable formations in which natural gas (methane) is found under pressure, providing a conduit through which that gas flows to the surface.[23] Shale gas, by contrast, is trapped in non-permeable rock found at great depths (usually 4000–10,000 feet) below the Earth's surface.[24] In the last decade or so, oil

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opinion/sean-lennon-destroying-precious-land-for-gas.html?_r=4&hp& (charging gas companies with lack of concern over the effects of fracking, and with the intention to "fracture our little town.").

21. *See, e.g.*, Jordo Bivona, *Chesapeake's Fracking Stirs Fears*, THE MOTLEY FOOL (Nov. 29, 2012), http://beta.fool.com/jordobivona/2012/11/29/chesapeakes-fracking-stirs-fears/17321 (evoking comparisons between the Fukushima nuclear accident and fears of fracking in Pennsylvania); Sabrina Artel, *How Fracking Is a Danger to Your Health*, ALTERNET (Oct. 1, 2012), http://www.alternet.org/fracking/how-fracking-danger-your-health.

22. The best-known pro-fracking industry group is Energy In Depth, which makes the scientific case for fracking. *See* ENERGY IN DEPTH, http://energyindepth.org (last visited Nov. 14, 2013); *see also* Kevin Begos, *Experts: Some Fracking Critics Use Bad Science*, ASSOCIATED PRESS (July 22, 2012, 6:44 PM), *available at* http://bigstory.ap.org/article/experts-some-fracking-critics-use-bad-science (disputing allegations of critics); *The Facts About Hydraulic Fracturing and Seismic Activity*, http://www.api.org/~/media/Files/Policy/Hydraulic_Fracturing/Facts-HF-and-Seismic-Activity.pdf (last visited Nov. 14, 2013) (also challenging critics); Raymond G. Mullady Jr., *Fracking Chemicals Not Harmful*, POWER ENGINEERING (May 9, 2011), http://www.power-eng.com/articles/2011/05/fracking-chemicals-not-harmful.html.

23. Conventional natural gas may be found dissolved in the oil, or as a cap on top of underground oil formations (so-called "associated gas," because it was associated with oil production); alternatively, it may be found between rock formations in the absence of oil ("unassociated gas").

24. Some shale gas formations are even deeper. For a good description of the major shale gas formations in the United States, including data on their respective

and gas production and service companies have coupled an old technique, hydraulic fracturing, with a relatively new one, horizontal drilling, to produce natural gas from shale formations in an economical way. Hydraulic fracturing involves the injection of fluids deep into the ground at high pressure to fracture rock, thereby creating openings that allow gas to flow into production wells.[25] This form of fracking was first used widely in the Barnett Shale (Texas) and the Haynesville Shale (Louisiana), but quickly spread to other areas, including North Dakota's Bakken Shale, Arkansas' Fayetteville Shale, the Eagle Ford Shale in south Texas, and the Marcellus Shale in the northeastern United States (see Figure 1). Americans currently consume about 25 trillion cubic feet (Tcf) of gas per year.[26] It is estimated that American shale deposits hold several hundreds of trillions of cubic feet of gas,[27] and that total U.S. reserves represent more than 100 years of U.S. consumption at current rates.[28] The recent commercial availability of all of this gas has, for the first time, separated American natural gas prices from oil prices, and driven gas prices down below $4.00 per million Btu (MmBtu), as compared with more than $10/MmBtu only a few years

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depths, see GROUND WATER PROTECTION COUNCIL, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER 17, http://www.netl.doe.gov/technologies/oil-gas/publications/epreports/shale_gas_primer_2009.pdf.

25. *Id*. at ES–4.

26. *Natural Gas Consumption by End Use*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm (last updated Oct. 31, 2013).

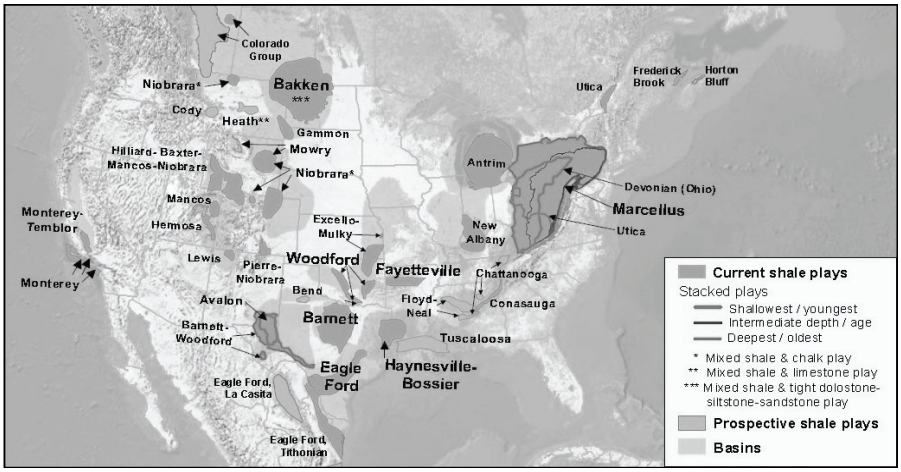
27. Estimates of technically recoverable amounts of gas are frequently revised by the U.S. Energy Information Administration (EIA) and the U.S. Geological Survey, two of the more widely followed sources of data on this topic. The EIA's estimates have fluctuated between around 400 Tcf and 800 Tcf recently. *See Technically Recoverable Shale Gas Resources Jump 134 Percent*, INST. FOR ENERGY RES. (May 16, 2011), http://www.instituteforenergyresearch.org/2011/05/16/technically-recoverable-shale-gas-resources-jump-134-percent.

28. The EIA's most recent estimate of technically recoverable reserves is approximately 2200 Tcf. *Frequently Asked Questions: How Much Natural Gas Does the United States Have and How Long Will It Last?*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/faqs/faq.cfm?id=58&t=8 (last updated Aug. 29, 2012). This is a considerable increase from previous estimates, which fluctuated between approximately 350 and 850 Tcf. INST. FOR ENERGY RES., *supra* note 27.

ago.[29] This has created boomtowns,[30] and the prospect of inexpensive natural gas for the foreseeable future has triggered plans for new industrial development in industries that use natural gas as an input.[31]

Figure 1: American Shale Gas Plays (Formations), May 2011

Figure Source: U.S. Energy Information Administration[32]



In addition to its economic benefits, the shale gas boom has produced some environmental benefits as well, most of which are associated with the displacement of coal by suddenly inexpensive natural gas in the electric generation sector. Natural gas combustion

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29. *Natural Gas Prices*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm (last updated Oct. 31, 2013).

30. *See e.g.*, *North Dakota Boomtown Suffers Growing Pains Trying to Keep Up with Demand* (PBS NewsHour television broadcast Aug. 7, 2012), *available at* http://www.pbs.org/newshour/bb/business/july-dec12/boomtown_08-07.html; Deon Daugherty, *A Look Inside an Eagle Ford Boomtown—and Its Traffic*, HOUSTON BIZBLOG (Oct. 28, 2011, 1:46 PM), http://www.bizjournals.com/houston/blog/2011/10/a-look-inside-an-eagle-ford-boomtown—.html?page=all.

31. *See* AM. CHEMISTRY COUNCIL, SHALE GAS AND NEW PETROCHEMICALS INVESTMENT: BENEFITS FOR THE ECONOMY, JOBS, AND US MANUFACTURING (2011), http://chemistrytoenergy.com/sites/chemistrytoenergy.com/files/ACC-Shale-Report.pdf

32. This figure was adapted from a full-color map of North American shale gas plays produced by the EIA, *Lower 48 States Shale Plays*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/oil_gas/rpd/shale_gas.pdf (last updated May 9, 2011).

produces far less pollution than oil or coal combustion.[33] Recent additions to U.S. electric generating capacity from gas-fired plants have outpaced additions of new coal-fired capacity.[34] In April 2012, coal-fired power's share of American electricity generation fell to about the same level as natural gas for the first time ever,[35] and energy-related carbon dioxide emissions in the United States during the first quarter of 2012 were at their lowest levels since 1992, a fact the U.S. Energy Information Administration (EIA) attributed to a combination of demand factors and the displacement of coal-fired power by natural gas-fired power.[36] The substitution of gas-fired for coal-fired electric generation should yield significant non-climate related benefits as well, since natural gas combustion produces far fewer of the more deadly toxic pollutants (such as sulfur dioxide, nitrogen oxides, particulate matter, and mercury) emitted by coal combustion.

At the same time, shale gas production produces significant negative environmental externalities as well. The process of fracking a well is organized and executed at the surface, on a concrete pad

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33. *See Natural Gas,* EPA, http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html (last updated Sept. 25, 2013) (comparing the emissions of coal combustion with those of natural gas combustion).

34. In most wholesale electricity markets electric generating plants are "dispatched"—that is, authorized to supply power to customers over the electric grid—on a marginal cost basis, with the least expensive plants dispatched first, thereby commanding more customers. In other words, subject to certain requirements aimed at maintaining the reliability and security of the electric system, at any given time of day the available generating facilities operating at the lowest marginal cost are dispatched first to meet additional demand. Prospective investors know this, and seek to invest in power plants that are likely to hold a favorable place in the dispatch order.

35. *Short-Term Energy and Winter Fuels Outlook*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/forecasts/steo/query/index.cfm?periodType=MONTHLY&startYear=1994&endYear=2014&formulas=x146x1g (last updated Oct. 8, 2013); *see also* Guy Chazan, *Shale Gas Boom Helps Slash US Emissions*, FIN. TIMES (May 23, 2012, 11:57 PM), http://www.ft.com/intl/cms/s/0/3aa19200-a4eb-11e1-b421-00144feabdc0.html#axzz2gsxPKDRz (quoting IEA chief economist Fatih Birol supporting this conclusion).

36. *U.S. Energy-Related CO_2 Emissions in Early 2012 Lowest since 1992*, U.S ENERGY INFO. ADMIN. (Aug. 1, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=7350. Some opponents of shale gas production dispute the climate effects of substituting shale gas for coal in electric generation. *See infra* Part I.B.3.

roughly the size of a football field. Fracking uses very large volumes of water—millions of gallons per fracking operation—which may strain water supplies in arid parts of the country.[37] The use of so much water requires hundreds or thousands of tanker truck trips to the well pad site, and the construction of lagoons or other storage facilities for fluids. So-called fracking fluids will be handled (and may be mixed) at the well pad site, posing the risk of spills. While fracking fluid mixtures are usually more than ninety-five percent water and sand,[38] the remainder of the mixture consists of various chemicals designed to enhance the efficiency of the fracturing process for the particular rock formation being fractured.[39] Some fracking fluid constituents are toxic,[40] and some fracking mixtures contain known carcinogens.[41] The oil and gas industry is developing fracking fluid mixtures that contain non-toxic or less toxic constituents, but it does not appear that these alternatives are yet in wide use.[42]

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37. *See, e.g.*, Kate Galbraith, *Texas Study Finds Increased Use of Water for Fracking*, TEX. TRIB. (Jan. 15, 2013), http://www.texastribune.org/2013/01/15/texas-study-traces-fracking-and-water-use (detailing the strains on water supplies in Texas).

38. Sand is the "proppant" that props open spaces in the rock in a durable way after the water pressure is reduced and the water flows away from the fractures.

39. The components of fracturing fluids have become generally known over the last few years, in part because of efforts by regulatory agencies to compel disclosure, and in part because of voluntary disclosure efforts by natural gas producers and their contractors. For a primer on fracturing fluid composition, see GROUND WATER PROTECTION COUNCIL, *supra* note 24.

40. For a thorough discussion of the toxicity of constituents of fracturing fluids, see Jay Kimball, *Congress Releases Report on Toxic Chemicals Used in Fracking*, 8020 VISION (Apr. 17, 2011), http://8020vision.com/2011/04/17/congress-releases-report-on-toxic-chemicals-used-in-fracking; *Chemicals & Public Disclosure*, FRACFOCUS, www.fracfocus.org/chemical-use/chemicals-public-disclosure (last visited Nov. 5, 2013).

41. *Id.* Industry groups argue that these same constituents are commonly found in many other household products. *See, e.g.*, Ken Cohen, *"Fracking" Fluid Disclosure: Why It's Important*, EXXONMOBIL PERSPECTIVES (Aug. 25, 2011), http://www.exxonmobilperspectives.com/2011/08/25/fracking-fluid-disclosure-why-its-important (detailing some of the common household products containing the same chemicals found in fracturing fluid mixtures).

42. *See New EPA-Approved Fracking Fluid 100% Green: SteriFrac Makes Fracking Process Safe for Oil & Gas Industry*, BUS. WIRE (Jan. 10, 2012, 11:00 AM), http://www.businesswire.com/news/home/20120110005568/en/EPA-

The well pad houses industrial equipment, including compressors and generators which, along with the truck traffic, will create the kind of noise, air emissions, and other activity associated with industrial land uses. The injection of fracking fluids into the ground to fracture rock will produce wastewater: "flowback water" (fracking fluids that return to the surface) and produced water (from deepwater aquifers) that may contain salts and naturally occurring toxic elements, such as arsenic, as well as radioactivity.[43] Current wastewater disposal options include direct disposal into surface waters through a point source, injection of the wastewater into an underground injection well,[44] disposal through a wastewater treatment facility,[45] and recycling the water (that is, reusing it in other fracking operations). However, in some parts of the country, underground injection is neither easy nor available; and depending upon the characteristics of the produced water, it may be difficult or

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Aproved-Fracking-Fluid-100-Green; Emran Hussain, *Baker Hughes Launches Green Fracking Fluid Systems*, ARABIAN OIL AND GAS (Dec. 9, 2010), http://www.arabianoilandgas.com/article-8157-baker-hughes-launches-green-fracking-fluid-systems/1/#.UniF_flwoyg. Some natural gas producers have begun to advocate "propane fracking," a technique for fracturing rock which uses liquid propane instead of conventional fracking fluids, claiming "100% recovery" of fracking fluids in the process. *See, e.g.*, *Safer Energy Solutions*, GASFRAC ENERGY SERVICES, http://www.gasfrac.com/safer-energy-solutions.html (last visited Nov. 14, 2013).

43. *See* William J. Kemble, *Kingston Won't Accept Fracturing Fluids at Sewage Treatment Plant, City Engineer Says*, DAILY FREEMAN NEWS (Dec. 19, 2011, 11:05 PM), http://www.dailyfreeman.com/articles/2011/12/19/news/doc4eee73521641a869886272.txt (citing problems associated with the presence of salts and radioactive materials in wastewater from fracturing operations). Wastewater can become radioactive because of radioactive elements that enter the water deep in the ground. For a good description of these so-called "naturally-occurring radioactive materials" (NORM), see *Oil and Gas Production Wastes*, EPA, http://www.epa.gov/radiation/tenorm/oilandgas.html (last visited Nov. 14, 2013).

44. This would require an underground injection well permit under the Safe Drinking Water Act, 42 U.S.C. § 300(h) (2012). The original injection of fluids for fracking purposes does not require such a permit by virtue of an exemption established in the 2005 Energy Policy Act. § 300(h)(d)(1)(B)(ii).

45. This kind of discharge would be subject to Clean Water Act pretreatment standards, which prohibit discharges that "interfere" with the operation of the plant or cause pollutants to "pass through" to surface waters. *See* 40 C.F.R. § 403.5(a)(1).

impossible to obtain the required Clean Water Act permission[46] to discharge the wastewater directly into surface waters or to pretreatment facilities. Furthermore, underground injection of wastewater from fracking operations in the wrong location can trigger seismic events.[47] Recent earthquakes linked in news reports to fracturing operations in Ohio,[48] Oklahoma,[49] and Arkansas[50] all appear to be the product of disposal of wastewater from gas production operations. Some experts believe, however, that "micro-seismicity" can result directly from fracking operations under certain conditions,[51] though fracturing-induced tremors ought to be far

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46. This kind of discharge would be subject to the requirement to obtain and National Pollutant Discharge Elimination System (NPDES) permit under section 402 of the Clean Water Act. 33 U.S.C. § 1342.

47. Underground injection of wastewater from gas production operations may have triggered earthquakes in Ohio and Texas recently. *See* Pete Spotts, *How Fracking Might Have Led to an Ohio Earthquake*, THE CHRISTIAN SCI. MONITOR (Jan. 2, 2012), http://www.csmonitor.com/Science/2012/0102/How-fracking-might-have-led-to-an-Ohio-earthquake; David J. Hayes, *Is the Recent Increase in Felt Earthquakes in the Central US Natural or Manmade?*, U.S. DEP'T OF INTERIOR (Apr. 11, 2012), http://www.doi.gov/news/doinews/Is-the-Recent-Increase-in-Felt-Earthquakes-in-the-Central-US-Natural-or-Manmade.cfm. Some fear that fracking operations (rather than wastewater disposal operations) are to blame. *See* Henry Fountain, *Add Quakes to Rumblings Over Gas Rush*, N.Y. TIMES (Dec. 12, 2011), http://www.nytimes.com/2011/12/13/science/some-blame-hydraulic-fracturing-for-earthquake-epidemic.html.

48. *Id.* (noting that quakes reported in Ohio appear to be associated with a deep wastewater disposal well located near a fault line).

49. John Daly, *U.S. Government Confirms Link between Earthquakes and Fracking*, OILPRICE (Nov. 8, 2011, 1:49 PM), http://oilprice.com/Energy/Natural-Gas/U.S.-Government-Confirms-Link-Between-Earthquakes-and-Hydraulic-Fracturing.html (noting that the Oklahoma quakes were near 181 underground injection wells for disposal of wastewater).

50. Alec Liu & Jeremy A. Kaplan, *Earthquakes in Arkansas May Be Man-Made, Experts Warn*, FOX NEWS (Mar. 1, 2011), http://www.foxnews.com/scitech/2011/03/01/fracking-earthquakes-arkansas-man-experts-warn (ascribing Arkansas quakes to underground injection wells).

51. Austin Holland, *Examination of Possibly Induced Seismicity from Fracking in the Eola Field, Garvin County, Oklahoma*, OKLA. GEOLOGICAL SURV. 1 (2011), http://www.ogs.ou.edu/pubsscanned/openfile/OF1_2011.pdf (hypothesizing that depending upon subsurface conditions, water used in the fracturing process could cause small tremors). *See also* Garry White, *Cuadrilla Admits Drilling Caused Blackpool Earthquakes*, TELEGRAPH (Nov. 2, 2011, 12:36 PM), http://www.telegraph.co.uk/finance/newsbysector/energy/8864669/Cuadrilla-

smaller in magnitude than those associated with underground injection for disposal, all else equal.[52]

Some shale gas production regions have experienced boomtown effects. Truck traffic can destroy local roads built for smaller vehicles and smaller traffic volumes, and the boom in people and traffic can burden other local infrastructure.[53] The sudden creation of job opportunities in a production region can change local economies. For example, truck drivers in the Eagle Ford Shale in South Texas make as much as $80,000 per year,[54] and high school graduates are opting for high-paying energy industry jobs over college in some energy boomtowns. The presence of these relatively highly paid workers in significant numbers can cause inflation, rendering goods and services unaffordable (or less affordable) to locals, some of who do not benefit financially from the production boom.[55] It is the domestic equivalent of the famous "oil curse."[56] In addition, the influx of (mostly male) workers to boomtowns can also cause social problems, bringing prostitution and increased alcohol consumption to formerly

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admits-drilling-caused-Blackpool-earthquakes.html (experts concluded that it is "highly probable" that small tremors were caused by fracturing operations).

52. Fountain, *supra* note 47 ("Scientists say the likelihood of that link is extremely remote, that thousands of fracking and disposal wells operate nationwide without causing earthquakes, and that the relatively shallow depths of these wells mean that any earthquakes that are triggered would be minor."); GROUND WATER PROTECTION COUNCIL, *supra* note 24, at ES–19 ("there is essentially no increased risk to the public, infrastructure, or natural resources from induced seismicity" related to fracking, in part because the micro-tremors created by fracturing "are too small to be felt, or to cause damage at the ground surface or to nearby wells.").

53. *See* Jim Efstathiou Jr., *Taxpayers Pay as Fracking Trucks Overwhelm Rural Cow Paths*, BLOOMBERG (May 15, 2012, 12:19 PM), http://www.bloomberg.com/news/2012-05-15/taxpayers-pay-as-fracking-trucks-overwhelm-rural-cow-paths-1-.html.

54. Vicki Vaughan, *Truckers Wanted for Eagle Ford Shale Jobs*, HOUS. CHRON. (Apr. 12, 2012), http://www.chron.com/business/article/Truckers-wanted-for-Eagle-Ford-Shale-jobs-3478594.php.

55. *See* Daugherty, *supra* note 30; *see also* North Dakota Boomtown, *supra* note 30.

56. The "oil curse" refers to the trend observed in some oil rich countries of reduced economic performance after discovery of oil. For a full description of its many variants and potential causes, see MICHAEL L. ROSS, THE OIL CURSE: HOW PETROLEUM WEALTH SHAPES THE DEVELOPMENT OF NATIONS (2012).

quiet communities.[57] Oil and gas companies have tried to minimize these effects by placing so-called "man camps" away from existing towns, but some of these effects persist nevertheless.

Finally, shale gas production releases methane and volatile organic chemicals (VOCs) into the atmosphere through leaks in gas capture, gathering, storage and transmission equipment. Methane is an extremely potent greenhouse gas.[58] Depending upon the volume of methane releases from any particular natural gas production operation, those releases may obviate any greenhouse gas emissions gains associated with the substitution of natural gas for coal in electricity production or other industrial operations. However, as described in the next section, there remains considerable uncertainty about the magnitude and climate effects of these so-called fugitive methane emissions.[59]

B. *The Disputed Effects of Fracking*

The nature and magnitude of some of fracking's other effects remain in dispute. Nor has the growing scientific literature examining these effects helped the combatants in the fracking debate to find common ground. To the contrary, each side of the debate draws very different conclusions from that literature.

1. The Combatants

Concern about the risks of fracking has spawned countless local opposition groups in communities where shale gas is produced. Some local governments have enacted ordinances banning fracking in their cities and towns,[60] while other local governments have been

57. Peter Foster & Alastair Good, *Boomtown USA*, THE TELEGRAPH (Nov. 25, 2013, 12:45 PM), http://www.telegraph.co.uk/earth/energy/fracking/10464709/Boomtown-USA-how-fracking-jumpstarted-Williston.html.

58. Since methane is among the most potent greenhouse gases—its heat trapping abilities far exceed that of carbon dioxide on a molecule by molecule basis—these methane emissions have the potential to erase any greenhouse gas emissions gains associated with switching from coal-fired power to natural gas-fired power.

59. See *infra* Part I.B. for a discussion of this issue.

60. This, in turn has triggered litigation challenging those bans on preemption or other grounds. The FracTracker website keeps track of anti-fracking ordinances in New York State, for example. *Current High Volume Horizontal Hydraulic*

generally supportive of fracking, mainly on economic development grounds.[61] The major national environmental groups have been split over the relative merits of shale gas production,[62] and none have joined local and single-issue groups in support of a national ban.[63] Indeed, one commentator speaks of the "divided heart of the anti-fracking movement," distinguishing "pragmatists" seeking reform from "idealists" seeking to ban fracking.[64] The Environmental

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Fracturing Drilling Bans and Moratoria in NY State, FRACTRACKER, http://www.fractracker.org/maps/ny-moratoria (last visited Nov. 14, 2013). *See also* Andrew Harris, *Colorado Cities Sued over Fracking Bans by Oil and Gas Group*, BLOOMBERG BUS. WK. (Dec. 4, 2013), http://www.businessweek.com/news/2013-12-03/colorado-cities-sued-over-fracking-ban-by-oil-gas-group.

61. *Id.*

62. As far as I am aware, no major national environmental group supports a national ban on fracking. The Natural Resources Defense Council has adopted the role of helping local communities oppose fracking. *See, e.g.*, *Don't Get Fracked*, NAT. RESOURCES DEF. COUNS., http://www.nrdc.org/health/drilling (last visited Nov. 14, 2013). The Sierra Club has established its Fracking Regulation Action Center, a website designed to provide information to local communities "to help secure strong safeguards for fracking." *FRAC: Fracking Regulatory Action Center*, SIERRA CLUB, http://www.sierraclub.org/naturalgas/rulemaking (last visited Nov. 14, 2013). The Environmental Defense Fund, by contrast, has been generally supportive of responsible shale gas production, though it continues to study the problem of methane leakage. *See* Rob Wile, *The Environmental Defense Fund Comes Out in Support of Fracking*, BUS. INSIDER (Sept. 12, 2012), http://www.businessinsider.com/environmental-defense-fund-supports-fracking-2012-9.

63. Perhaps the highest-profile proponent of a ban is 350.org, a national group focused on climate change. One lesser-known national group, Food and Water Watch, also vigorously opposes fracking. The group publishes a number of fact sheets which allege a close connection between fracking and severe environmental harm. *See, e.g.*, *Waste: The Soft and Dirty Underbelly of Fracking*, FOOD & WATER WATCH (Apr. 2012), http://documents.foodandwaterwatch.org/doc/UnderbellyOfFracking.pdf (of which the major headings are "The Fracking Nightmare," "Rivers of Toxic Wastewater," and "Mountains of Toxic Waste").

64. Adam Briggle, *Should Cities Ban Fracking?*, SLATE MAG. (Dec. 24, 2012, 9:00 AM), http://www.slate.com/articles/technology/future_tense/2012/12/longmont_co_has_banned_fracking_is_that_a_good_idea.html. *See also* Richard A. Muller & Elizabeth A. Muller, *Why Every Serious Environmentalist Should Favor Fracking*, CTR. FOR POL'Y STUDIES (2013), http://www.cps.org.uk/files/reports/original/131202135150-WhyEverySeriousEnvironmentalistShouldFavourFracking.pdf (chronicling the environmental benefits of substituting gas for other fossil fuels).

Defense Fund's (EDF) participation in "The Center for Sustainable Shale Gas Development," and collaboration with energy companies and philanthropic organizations to develop performance standards for shale gas production, has further exposed this division in the environmental community.[65] However, despite the failure of major environmental organizations to call for an outright ban, many entertainment industry figures have embraced the idealists' position, often framing the issue as one of people versus profits. The academy award-nominated documentary *Gasland* helped to rally opposition to fracking. The film depicts a variety of environmental ills in gas production regions and implies that fracking is responsible for those ills. For example, residents who live near natural gas drilling are shown lighting their tap water on fire, suggesting that drilling operations caused methane to leach into their well water. Similarly, the movie shows the mayor of a Texas town who believes that pollution associated with fracking operations has increased the incidence of serious illnesses among his constituents.[66] In a 2012 *New York Times* op-ed piece entitled "Destroying Precious Land for Gas," Sean Ono Lennon contended that fracking "inevitably leaks toxic chemicals into the air and water,"[67] a notion echoed by actor-turned-activist Mark Ruffalo, now a leader of the anti-fracking movement.[68] These disparate opposition groups and prominent

65. *See* Susan Phillips, *Fractures in the Anti-Fracking Community*, ST. IMPACT (May 21, 2013, 6:19 PM), http://stateimpact.npr.org/pennsylvania/2013/05/21/fractures-in-the-anti-fracking-movement (reporting that other environmental groups are "shunning" EDF for their participation in the regulatory effort with industry).

66. Specifically, the film interviews Calvin Tillman, then the mayor of Dish, Texas, and now an anti-fracking activist. *See* GASLAND (HBO Documentary Films 2010).

67. Lennon, *supra* note 20.

68. Ruffalo has said that "[i]t has yet to be proven that we *can* frack without destroying our water and air. If it can be done, why aren't they doing it?" *See* Jeff Goodell, *Mark Ruffalo on the Fracking Fight*, ROLLING STONE (May 16, 2012, 10:29 AM), http://www.rollingstone.com/politics/blogs/national-affairs/mark-ruffalo-on-the-fracking-fight-20120516. *See also* Mireya Navarro, *Ruffalo Embraces a Role Closer to Home*, N.Y. TIMES (Dec. 2, 2011), http://www.nytimes.com/2011/12/04/fashion/mark-ruffalo-actor-embraces-anti-fracking-role.html?pagewanted=all&_r=0 (describing Ruffalo's role as an organizer of the anti-fracking movement within the entertainment industry). Most recently, the feature film *Promised Land* focuses on the ethical quandaries facing a "land man" (one who secures mineral rights from property owners) played by Matt Damon.

entertainment industry figures have coalesced under the umbrella of an organization called "Americans Against Fracking,"[69] dedicated to banning the use of hydraulic fracturing in shale gas production[70] because fracking poses "a direct and immediate threat to the drinking water, air, climate, food, health and economies of communities across the United States."[71]

The counterparts to anti-fracking activists are mainly those who stand to benefit from shale gas production—industry representatives, landowners who have leased their land for production, and some of those who benefit from the secondary economic effects of the shale gas boom described in the previous section.[72] An oil and gas trade group has launched a web site called "Energy In Depth" which is "focused on getting the facts out about the promise and potential of responsibly developing" shale gas. Much of the Energy in Depth website is devoted to "debunking" the claims of fracking's opponents and challenging new criticisms leveled against fracking.[73]

In the middle stand state and federal politicians and regulators, who have reacted to the boom in shale gas production in more

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PROMISED LAND (Focus Features 2012). In the film, Damon's employer takes a particularly cynical approach to its dealings with landowners.

69. The organization's advisory board consists of filmmaker Josh Fox, singer Natalie Merchant, actor Mark Ruffalo, and ecologist Susan Steingraber. *Advisory Board*, AMERICANS AGAINST FRACKING, www.americansagainstfracking.org/about-the-coalition/advisory-board (last visited Nov. 14, 2013).

70. The "About the Coalition" section of the Americans Against Fracking website says that "[o]ur goal, quite simply, is to ban fracking. To that end, we support federal, state and local efforts to ban fracking, enact moratoriums and to stop practices that facilitate fracking like natural gas exports, frac sand mining and the construction of pipelines." *About the Coalition*, AMERICANS AGAINST FRACKING, http://www.americansagainstfracking.org/about-the-coalition (last visited Nov. 14, 2013).

71. *Id.*

72. The signatories on a letter supporting fracking sent to President Obama in 2011 offer a representative snapshot of pro-fracking groups. They include manufacturers, chambers of commerce, as well as oil and gas interests. *See* Letter from 60 Plus et al. to Barack H. Obama, President of the United States of America (Sep. 20, 2011), *available at* http://www.slideshare.net/MarcellusDN/hydraulic-fracturing-jobs-and-security-letter-to-obama-92011?utm_source=slideshow02&utm_medium=ssemail&utm_campaign=share_slideshow_loggedout.

73. *See* ENERGY IN DEPTH, www.energyindepth.org (last visited Nov. 14, 2013).

measured ways, revising and strengthening environmental rules in response to new information about the environmental risks of the industry as the information arises.[74] For example, the states of Texas and Pennsylvania, both experiencing shale gas production booms, have revised their regulations in the last couple of years to close perceived regulatory gaps.[75] In New York, a ban remains in place pending further study; but New York's ban is the exception rather than the rule. At the federal level, the Obama Administration's reaction to the shale boom was centered on the Secretary of Energy's Advisory Board (SEAB), Subcommittee on Shale Gas Production. After studying the issue, the SEAB subcommittee produced a list of recommendations designed to promote responsible Shale gas development.[76] Many of the subcommittee's recommendations require action by other governmental entities, some of which have been undertaken. For example, the Environmental Protection Agency (EPA) has announced its intention to strengthen its Clean Water Act rules governing disposal of wastewater from hydraulic fracturing operations,[77] and Clean Air Act rules governing fugitive VOC (including methane compound) emissions from natural gas operations.[78] Meanwhile, the EPA is engaged in a long-term study of the effects of fracking, the results of which are expected in 2014.[79]

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74. Hannah Wiseman, a leading authority on state regulation of shale gas production, calls this process "regulatory adaptation." *See* Hannah Wiseman, *Regulatory Adaptation in Fractured Appalachia*, 21 VILL. ENVTL. L.J. 229 (2010); Hannah Wiseman, *Untested Waters: The Rise of Fracking in Oil and Gas Production and the Need to Revisit Regulation*, 20 FORDHAM ENVTL. L. REV. 115 (2009).

75. *See, e.g.*, Hydraulic Fracturing Chemical Disclosure Requirements, 16 TEX. ADMIN. CODE § 3.29 (2013); Press Release, Pa. Dep't of Envtl. Prot., DEP Announces Final Air Quality Permit for Natural Gas Operations, Proposes New Environmental Controls (Jan. 31, 2013), *available at* http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=19840&typeid=1.

76. SHALE GAS PROD. SUBCOMM., SEC'Y OF ENERGY ADVISORY BD., U.S. DEP'T OF ENERGY, SECOND NINETY DAY REPORT (Nov. 18, 2011), http://www.shalegas.energy.gov/resources/111811_final_report.pdf.

77. Nicholas Kusnetz, *EPA Plans to Issue Rules Covering Fracking Wastewater*, PROPUBLICA (Oct. 20, 2011, 5:01 PM), http://www.propublica.org/article/epa-plans-to-issue-rules-covering-fracking-wastewater.

78. *See* Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 77 FED. REG.

2. Water Pollution

As suggested by *Gasland*, much of the early opposition to fracking focused on concern that fracking would cause water contamination. Three high profile water contamination incidents in shale gas production regions have fed concern about water pollution risks. The first involved the contamination of drinking water wells with methane in Dimock, Pennsylvania in 2009.[80] Cabot Oil and Gas Corporation, a shale gas producer, entered into a consent decree in which it agreed to pay a fine and to provide fresh water to residents of Dimock. Fracking proponents contend that fracking was not the cause of the Dimock contamination. Nevertheless, the incident figures prominently in anti-fracking campaigns. Also in 2009, an algae bloom in Dunkard Creek in West Virginia resulted in a massive fish kill. The EPA and the West Virginia Department of Environmental Protection concluded that drainage from a nearby coal mine caused the spill, but some fracking activists (and an EPA biologist) believe that wastewater from fracking operations may be the cause.[81] Finally, in 2011, the EPA concluded that fracturing fluids

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49,490 (Aug. 16, 2012) (to be codified at 40 C.F.R. pts. 60 and 63) (creating new source performance standards for onshore natural gas processing plants and finalizing risk- and technology-review procedures for natural gas production, transmission, and storage). Existing equipment standards can be found at 40 C.F.R. pt. 60 subpart KKK.

79. For outline of the EPA's study plan, see OFF. OF RES. AND DEV., EPA, PLAN TO STUDY THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES (2011), http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/hf_study_plan_110211_final_508.pdf.

80. *See* Michael Rubinkam, *Pa. Moves to Limit Air Emissions from Gas Industry*, ASSOCIATED PRESS (Feb. 1, 2013), *available at* http://news.yahoo.com/pa-moves-limit-air-emissions-163446600.html. Similar claims have been brought against Southwest Energy Production Company and Atlas Energy. *See* Berish v. Sw. Energy Prod. Co., 763 F. Supp. 2d 702, 704 (M.D. Pa. 2011); Jon Hurdle, *Pennsylvania Lawsuit Says Drilling Polluted Water*, REUTERS (Nov. 9, 2009, 9:37 AM), http://www.reuters.com/article/2009/11/09/us-fracking-suit-idUSTRE5A80PP20091109. While the settlement did not establish the cause of the methane contamination, the Pennsylvania Department of Environmental Protection subsequently banned Cabot from using hydraulic fracturing in the region.

81. Mike Soraghan, *In Fish-Kill Mystery, EPA Scientist Points at Shale Drilling*, N.Y. TIMES, (Oct. 12, 2011), http://www.nytimes.com/gwire/2011/10/12/12greenwire-in-fish-kill-mystery-epa-scientist-points-at-s-86563.html?pagewanted=all.

had contaminated a drinking water aquifer near the town of Pavilion, Wyoming,[82] though the industry disputes that conclusion.[83]

Meanwhile, researchers have turned their attention to the risk of water contamination from fracking. A 2011 Cornell University study found a higher incidence of methane contamination in drinking-water wells located close to natural gas wells,[84] though that study did not distinguish between biogenic methane (found at shallow depths) and thermogenic methane (found at greater depths, where fracking occurs). Nor did the study sample wells before fracking operations commenced, leaving open the possibility that the methane was in the groundwater beforehand. A 2011 Pennsylvania State University study sampled drinking-water wells before and after nearby fracking operations, and found no significant increase in well contamination from either methane or fracking fluid constituents.[85] Earlier findings by MIT researchers reached similar, though tentative, conclusions.[86] The so-called "Duke Study" sampled well water before and after fracking and reached mixed conclusions, finding no evidence of

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82. *See* DOMINIC C. DIGIULIO ET AL., EPA OFF. OF RES. AND DEV., DRAFT: INVESTIGATION OF GROUNDWATER CONTAMINATION NEAR PAVILLION, WYOMING (2011), http://www2.epa.gov/sites/production/files/documents/EPA_ReportOnPavillion_Dec-8-2011.pdf; *see also* Jim Efstahiou Jr., *Gas-Fracking Fracturing Chemicals Detected in Wyoming Aquifer, EPA Says*, BLOOMBERG NEWS (Dec. 8, 2011, 3:50 PM), http://www.bloomberg.com/news/2011-12-08/gas-fracking-chemicals-detected-in-wyoming-aquifer-epa-says.html.

83. The Independent Petroleum Association of America raised questions about the EPA study, which provoked a dialogue with EPA. *See*, Chris Tucker, **Update XIII* Six—Actually, Seven—Questions for EPA on Pavilion*, ENERGY IN DEPTH (Feb. 20, 2013, 9:09 AM), http://www.energyindepth.org/six-questions-for-epa-on-pavillion/.

84. Robert W. Howarth et al., Letter, *Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations*, 106 CLIMACTIC CHANGE 679 (2011).

85. ELIZABETH W. BOYER ET AL., CTR. FOR RURAL PA., THE IMPACT OF MARCELLUS GAS DRILLING ON RURAL DRINKING WATER SUPPLIES 16–18 (2011), http://www.rural.palegislature.us/documents/reports/Marcellus_and_drinking_water_2011_rev.pdf.

86. ERNEST J. MONIZ ET AL., THE FUTURE OF NATURAL GAS: AN INTERDISCIPLINARY MIT STUDY 39 (2011), http://mitei.mit.edu/system/files/NaturalGas_Report.pdf.

groundwater contamination by fracking fluids or wastewater,[87] but some evidence that levels of thermogenic methane were higher in shallow groundwater aquifers near natural gas-production wells than elsewhere in the same aquifers.[88] The authors could not say how long ago the thermogenic methane found its way to shallower depths, however, or whether gas drilling was connected with its presence there.[89] In 2012, researchers at the State University of New York at Stony Brook sought to quantify the risks of groundwater contamination by estimating the probabilities of various types of accidents that could result in a spill, and extrapolating from those probabilities to produce projected volumes of fracking wastewater that might find their way into groundwater or surface waters in the Marcellus Shale.[90] The authors concluded that the risks were "substantial." Most recently, the U.S. Geological Survey compared concentrations of methane and other constituents in 127 water wells in the Fayetteville shale gas production region before and after shale gas production operations, finding no evidence of contamination in either methane or fracking fluid constituents and wells.[91]

3. Air Pollution

Gasland raised the question of whether fracking produces dangerous air emissions (from truck traffic, compressors, etc.), and anti-fracking groups have charged that fracking is associated with

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87. *See* Stephen G. Osborn et al., *Methane Contamination of Drinking Water Accompanying Gas-Well Drilling and Hydraulic Fracturing*, 108 PROC. NAT'L. ACAD. SCI. 8172, 8175 (2011) ("we found no evidence for contamination of the shallow wells near active drilling sites from deep brines and/or fracturing fluids.").

88. *See id.* at 8174 ("The data do suggest gas-phase transport of methane upward to the shallow groundwater zones sampled for this study . . . .").

89. *See id.* at 8175.

90. Daniel J. Rozell & Sheldon J. Reaven, *Water Pollution Risk Associated with Natural Gas Extraction from the Marcellus Shale*, 32 RISK ANALYSIS 1383 (2011), *available at* http://www.slideshare.net/MarcellusDN/paper-water-pollution-risk-associated-with-natural-gas-extraction-from-the-marcellus-shale.

91. Timothy M. Kresse et al., *Shallow Groundwater Quality and Geochemistry in the Fayetteville Shale Gas-Production Area, North-Central Arkansas, 2011*, U.S. GEOLOGICAL SURV. ET AL. (2012), http://pubs.usgs.gov/sir/2012/5273/sir2012-5273.pdf.

increased incidence of breast cancer in parts of Texas.[92] However, these claims have been widely criticized by a variety of public health professionals.[93] More recently, two studies focusing on air pollution near gas sites in Colorado indicate that airborne levels of VOCs at those sites exceed national standards,[94] or that levels are high enough to warrant further study.[95] Industry critics, however, dispute those conclusions claiming that neither study measures the relative contribution of fracking operations and other nearby sources, such as interstate highway traffic.[96]

Fracking's opponents have also begun to challenge the notion that a transition from coal to natural gas will have climate benefits. Critics point to the fact that methane is itself a potent greenhouse gas, and note that methane can escape from natural gas pipelines and equipment, and from fracked wells during the well closure[97] process.

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92. Peggy Heinkel-Wolfe, *Breast Cancer Rate Climbs Up*, DENTON REC.-CHRON. (Aug. 31, 2011, 3:19 PM), http://www.dentonrc.com/local-news/special-projects/gas-well-drilling-headlines/20110831-breast-cancer-rate-climbs-up.ece; *see also* Jerving, *supra* note 20.

93. Begos, *supra* note 22.

94. Lisa Song, *Hazardous Air Pollutants Detected near Fracking Sites*, BLOOMBERG (Dec. 3, 2012, 7:02 PM), http://www.bloomberg.com/news/2012-12-03/hazardous-air-pollutants-detected-near-fracking-sites.html; David Kelly, *Study Shows Air Emissions near Fracking Sites May Pose Health Risk*, U. COLO. DENV. (Mar. 19, 2012), http://www.ucdenver.edu/about/newsroom/newsreleases/Pages/health-impacts-of-fracking-emissions.aspx; *see also* Mark Jaffe, *CU Denver Study Links Fracking to Higher Concentration of Air Pollutants*, DENV. POST (Mar. 20, 2012, 1:00 AM), http://www.denverpost.com/breakingnews/ci_20210720/cu-denver-study-links-fracking-higher-concentration-air.

95. Theo Colborn et al., *An Exploratory Study of Air Quality near Natural Gas Operations*, ENDOCRINE DISRUPTION EXCHANGE 11 (2012), http://endocrinedisruption.org/assets/media/documents/HERA12-137NGAirQualityManuscriptforwebwithfigures.pdf; Cathy Proctor, *Colorado to Study Air Pollution from Oil and Gas Operations*, DENV. BUS. J. (Jan. 9, 2013, 11:39 AM), http://www.bizjournals.com/denver/news/2013/01/09/colorado-to-study-air-pollution-from.html?page=all.

96. Steve Everley, **UPDATE IV** *Eight Worst Inputs Used in Colorado Health Study*, ENERGY IN DEPTH (May 16, 2012, 9:09 AM), http://www.energyindepth.org/non-elite-eight-worst-inputs-used-in-new-colorado-health-study.

97. Closure refers to the period when the well has stopped producing flowback water and is ready to be connected to gathering systems and produce only gas. As flowback water diminishes, more gas is found in the mixture. The EPA's recent

More natural gas production, they reason, means more methane in the atmosphere. The relative climate benefits of switching from coal and oil to gas, however, depend upon (1) relative methane leakage rates for these various fuels prior to combustion, and (2) how we compare greenhouse effects of methane to those of carbon dioxide (the primary greenhouse gas byproduct of coal, oil, and natural gas combustion). The combatants in the fracking debate disagree about both of these issues.

The scholarly debate on the methane leakage issue is just getting underway. One early study estimated that as much as eight percent of the methane produced from natural gas wells escapes into the atmosphere as the result of leaks or venting, an amount that could undermine the climate change advantages of natural gas.[98] That study, however, has attracted considerable criticism in the scholarly community. A report from Cambridge Energy Research Associates contends that the Howarth study is plagued by measurement and methodological errors that resulted in an overestimate of methane emissions from gas production operations. The alleged errors include failing to distinguish between methane emission rates from venting versus flaring of gas, failing to account for the standard industry practice of capturing methane in flowback water, and more.[99] The EPA estimates that methane emissions from natural gas-production facilities comprise less than three percent of American greenhouse gas emissions annually,[100] but studies underway by the National

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rule on fugitive emissions from gas facilities would reduce methane emissions associated with closure. *See* Oil and Natural Gas Sector, *supra* note 78.

98. *See* Howarth, *supra* note 84.

99. *See* CAMBRIDGE ENERGY RES. ASSOCIATES, MISMEASURING METHANE: ESTIMATING GREENHOUSE GAS EMISSIONS FROM UPSTREAM NATURAL GAS DEVELOPMENT (private report on file with author); *see also* David A. Kirchgessner et al., *Estimate of Methane Emissions from the U.S. Natural Gas Industry*, 35 CHEMOSPHERE 1365 (1997), *available at* http://www.epa.gov/ttnchie1/ap42/ch14/related/methane.pdf.

100. For a discussion of EPA's calculations, see Ramon A. Alvarez, et al., *Greater Focus Needed on Methane Leakage from Natural Gas Infrastructure*, 109 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 6435 (2012). The data used calculations taken from *Overview of Greenhouse Gases: Methane Emissions*, EPA, http://epa.gov/climatechange/ghgemissions/gases/ch4.html (last updated Sept. 9, 2013) (noting that methane emissions accounted for about nine percent of all U.S. greenhouse gas emissions from human activities and thirty percent of U.S. methane emissions come from natural gas and petroleum systems). *See also* KELSI

Oceanic and Atmospheric Administration have challenged those estimates as too low.[101] A recent University of Texas study measuring 2012 emissions at hundreds of natural gas production sites (many of which used reduced-emission well completion methods) concluded that leakage was lower than the EPA estimate.[102] Another recent study measured 2008–09 emissions from conventional natural gas production sites in Texas and Oklahoma, and concluded that emissions rates were higher than EPA estimates.[103] Methane leakage may be a technically tractable problem,[104] since companies have an economic incentive to capture fugitive emissions; and the EPA's recently-promulgated rule on fugitive emissions from natural gas facilities should reduce leakage rates (whatever those rates currently are).[105] Meanwhile, states and the EPA are considering additional regulation to address the problem.[106]

BRACMORT ET AL., CONG. RES. SERV., METHANE CAPTURE: OPTIONS FOR GREENHOUSE GAS EMISSION REDUCTION 23 (2009), http://fpc.state.gov/documents/organization/130799.pdf.

101. *See* Gabrielle Petron et al., *Hydrocarbon Emissions Characterization in the Colorado Front Range—A Pilot Study*, J. GEOPHYSICAL RES. (forthcoming 2012) (suggesting that existing estimates of fugitive methane emissions from gas operations are underestimates). *But cf.* Michael Levi, *Yellow Flags on a New Methane Study*, COUNCIL ON FOREIGN RELATIONS (Feb. 13, 2012), http://blogs.cfr.org/levi/2012/02/13/yellow-flags-on-a-new-methane-study (identifying methodological problems with the Petron study). Recently, the NOAA group announced results from a study of methane emissions in Utah that are consistent with the Howarth data. *See* Jeff Tollefson, *Methane Leaks Erode Green Credentials of Natural Gas*, 493 NATURE 12 (2013), *available at* http://www.nature.com/news/methane-leaks-erode-green-credentials-of-natural-gas-1.12123.

102. David T. Allen, et al., *Measurements of Methane Emissions at Natural Gas Production Sites in the United States*, 110 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 17768 (2013).

103. Scott M. Miller, et al., *Anthropogenic Emissions of Methane in the United States*, 110 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 17768 (2013).

104. *See* Jim Marston, *Elements: Shale Drilling Can Be A Win-Win*, AUSTIN AM.-STATESMAN (Jan. 21, 2013, 12:00 AM), http://www.statesman.com/news/news/opinion/elements-shale-drilling-can-be-a-win-win/nTyhF (detailing the Environmental Defense Fund's qualified support for shale gas production, with controls on methane leakage).

105. *See* Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 77 FED. REG. 49,490 (Aug. 16, 2012) (to be codified at 40 C.F.R. pts. 60 and 63); *see also* Adam

Methane leakage rates aside, the combatants in the fracking debate cannot agree on the relative climate impacts of methane versus carbon dioxide emissions—the so-called "methane multiplier."[107] A molecule of carbon dioxide emitted today persists in the atmosphere for approximately 100 years, compared to only twenty years for methane. During its 100 years in the atmosphere, that CO_2 molecule will trap roughly twenty-five times the heat of a methane molecule emitted today. However, during the twenty years of the methane molecule's existence in the atmosphere,[108] the methane molecule will trap roughly seventy-two times the heat of the CO_2 molecule (though the CO_2 molecule will continue to trap heat for another eighty years).[109] Anti-fracking groups use the 72x number (and, often, a

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Orford, *EPA to Regulate Air Emissions from Hydraulic Fracturing As Industry Comes Under Scrutiny*, MARTEN L. (May 29, 2012), http://www.martenlaw.com/newsletter/20120529-air-emissions-from-hydraulic-fracturing.

106. *See, e.g.*, Rubinkam, *supra* note 80 (describing Pennsylvania's effort to tighten methane leakage rules). Several states would like the EPA to further tighten its rules, or implement them more quickly. *See* Kevin Begos, *NY, 6 Other States Suing EPA Over Drilling Methane*, ASSOCIATED PRESS (Dec. 11, 2012, 6:40 PM), *available at* http://bigstory.ap.org/article/ny-6-other-states-suing-epa-over-drilling-methane (recounting litigation aimed at forcing more action on methane leakage by the EPA).

107. *See generally* Tom Zeller Jr., *Methane Losses Stir Debate on Natural Gas*, N.Y. TIMES GREEN BLOG (Apr. 12, 2011, 9:01 AM), http://green.blogs.nytimes.com/2011/04/12/fugitive-methane-stirs-debate-on-natural-gas (providing a detailed summary of the "methane multiplier" issue).

108. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, TS.2.5 NET GLOBAL RADIATIVE FORCING: GLOBAL WARMING POTENTIALS AND PATTERNS OF FORCING, IN CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS (2007), *available at* http://www.ipcc.ch/publications_and_data/ar4/wg1/en/tssts-2-5.html; *see also Beyond Kyoto: Why Climate Policy Needs to Adopt the 20-Year Impact of Methane*, ECO-CYCLE, www.ecocycle.org/files/pdfs/methane20yearimpactecocycle.pdf (last visited Oct. 16, 2013).

109. *See* Steven Hamburg, *Measuring Fugitive Methane Emissions from Fracking*, ECOWATCH (Jan. 4, 2013), http://ecowatch.org/2013/fugitive-methane-emissions-fracking; Thomas Schueneman, *EDF, Chevron Agree Natural Gas Fracking Here to Stay, Part Ways on Fugitive Methane Emissions and Short-Term Impacts of Shale Boom*, GLOBAL WARMING IS REAL (Feb. 6, 2013), http://globalwarmingisreal.com/2013/02/06/edf-chevron-agree-natural-gas-fracking-here-to-stay-part-ways-on-impact-of-methane-emissions; *see also Science and Research*, AM. ENERGY COAL., http://americanenergycoalition.com/scienceandresearch (last visited Nov. 6, 2013).

larger 105x multiplier)[110] when discussing the climate impacts of methane; if one wants to compare the full effects of each source of emissions over their entire lifetimes in the atmosphere, then the 25x multiplier is more appropriate.

Thus, there remain open questions about the impacts of fracking on air and groundwater. These debates, however, concern relatively narrow questions, and stand in contrast to the much broader and bolder claims made by combatants in the shale gas policy debate. Whereas disagreements in the scientific community play out in the language of cool analysis, the larger policy debate is characterized by a healthy dose of moral outrage and framed largely in ethical terms.

II. RESPONSIBLE DEVELOPMENT AND THE COMPLICATED ETHICS OF FRACKING

Many oil and gas companies invest heavily in corporate social responsibility-investments that address the environmental and social impacts of their actions, often going beyond legal requirements.[111]

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110. Those who use the 105x multiplier cite work by Drew Shindell, comparing the effects of carbon emissions from coal and gas by mass over a shorter than twenty-year time period. *See* Drew T. Shindell et al., *Improved Attribution of Climate Forcing to Emissions*, 326 SCI. 716, 717 (Oct. 30, 2009). For examples of authors using the 105x multiplier, see *California, Fracking and Tomorrow's Energy*, EARTHACTION (Feb. 26, 2013), http://www.earthaction.org/2013/02/california-fracking-and-tomorrows-energy.html; Iris Marie Bloom, *Fracked Gas Speeds Climate Crash; Extreme Flaring Adds to Greenhouse Emissions*, PROTECTING OUR WATERS (Nov. 28, 2011), http://protectingourwaters.wordpress.com/2011/11/28/fracked-gas-speeds-climate-crash-extreme-flaring-adds-to-greenhouse-emissions; Richard Matthews, *Natural Gas is Not Clean Energy*, GLOBAL WARMING IS REAL (Feb. 15, 2012), http://globalwarmingisreal.com/2012/02/15/natural-gas-is-not-clean-energy; *Rising Tide—Vancouver, Coast Salish Territories Opposes Fracking and Stands with Front-line Communities Against LNG Expansion*, RISING TIDE VANCOUVER COAST SALISH TERRITORIES (Feb. 25, 2013), http://calamites.resist.ca/?p=329; Stephen Leahy, *Shale Gas a Bridge to More Global Warming*, INTER PRESS SERV. (Jan. 24, 2012), http://www.ipsnews.net/2012/01/shale-gas-a-bridge-to-more-global-warming.

111. For a general discussion of corporate social responsibility in the oil and gas industry, see David B. Spence, *Corporate Social Responsibility in the Oil and Gas Industry: The Importance of Reputational Risk*, 86 CHI.-KENT L. REV. 59, 84 (2011).

These investments are alternately explained as investments in reducing legal or political risk, reactions to companies' social and environmental missteps in the past, sincere efforts to operate sustainably, and public relations.[112] How, then, might we define responsible shale gas production? The term "responsible" or "responsibility" implies a duty to someone or something, which in turn evokes at least some sort of general notion of ethics or morality—that is, a duty beyond that imposed in law. Risk regulation offers one approach to this question of what individuals, firms and policymakers *ought to do*, and suggests that they ought to choose courses of action that minimize risks to the public (the precautionary principle). This is, of course, distinct from the question of what individuals and firms are likely to *actually do* in particular situations, and why they do it; that is the domain of the behavioral sciences, such as economics, behavioral psychology, and the neurosciences.[113] The next section explores the *relative* risks of fracking, which have been under-emphasized in the fracking debate; Part II.B examines the debate's behavioral dimensions as a way of understanding why relative risks are often ignored.

A. Risk Regulation and the Fracking Debate

One cannot make responsible decisions about how to regulate a particular risk, like shale gas production, without recognizing the larger context in which that risk exists. It makes little sense to spend $2X to eliminate a small risk when one could spend $X to eliminate a much larger risk. Yet we sometimes make this kind of a logical choice because the smaller risk appears to be more salient or looms larger to more influential subsets of society.[114] Indeed, there is a

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112. *Id.* at 61–70 (discussing the various rationales for corporate social responsibility investments and the difficulty of discerning which are driving investments).

113. Thus, for example, while economists explain behavior by focusing on the rational, fully informed utility-maximizing individual ("rational man" or *homo economicus*), behavioral psychologists focus on the elements of behavior that are irrational or not well explained by the assumption of rationality. A behavioral analysis of a decision may yield predictions about the course of action people are likely to take, or plausible explanations of (ethical or unethical) behavior.

114. Of course, the literature on risk assessment and management is enormous. Perhaps the most succinct description of the sometime irrationality of risk

myopic quality to the policy debate over fracking. Discussions of whether to permit or prohibit shale gas production often focus on the most immediate impacts (costs and benefits), both temporally and geographically, without regard to the equally important, broader impacts of more or less shale gas production. Rather, policymakers ought to weigh the full costs and benefits of permitting, regulating, or banning fracking, including the longer-term, more widely distributed costs and benefits.

Such an analysis starts with the recognition that energy investment and production decisions are not made by government policymakers, for policy reasons: rather, they are made by the private sector, for economic reasons. That is, the energy industry produces fuels at different rates depending upon their relative profitability over time; and invests in the production of different fuels at different rates depending upon projections of their relative profitability over time. In capitalist systems, governments do very little in the way of direct investment in, or production of, energy; rather governments try to influence private sector investment and production decisions by regulating or subsidizing so as to raise (or lower) the cost of producing or using specific fuels. Thus, regulation that raises the *relative* cost of producing or using one fuel, all else equal, benefits other competing fuels.

Natural gas competes with coal, renewables, and nuclear power in the electric generation sector, and with oil in the transportation sector. The shale gas boom has brought dramatic change in the relative profitability of producing natural gas. Lower natural gas prices make the construction of natural gas-fired electric generating facilities a much more profitable proposition, to the disadvantage of coal-fired, nuclear, and renewable electric generation facilities. Similarly, the prospect of low natural gas prices into the foreseeable future is starting to give a boost to natural gas-fueled vehicles;[115] should that development continue, it will work to the relative

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regulation policy is that provided by then Judge Breyer in his book on the subject. *See* STEPHEN BREYER, BREAKING THE VICIOUS CIRCLE: TOWARD EFFECTIVE RISK REGULATION (1993).

115. This is particularly true of truck and bus fleets that return to a common location for refueling. *See* Ken Silverstein, *All Roads Lead to Natural Gas-Fueled Cars and Trucks*, FORBES (Dec. 15, 2012, 9:24 AM), http://www.forbes.com/sites/kensilverstein/2012/12/15/all-roads-lead-to-natural-gas-fueled-cars-and-trucks.

disadvantage of gasoline-fueled vehicles. Therefore, regulation that increases the cost of producing natural gas, or restricts supply, will increase prices, to the relative benefit of those competing fuels; similarly, regulation that increases the relative cost of producing other fuels benefits natural gas.

This is an important point. Proponents of wind-powered and nuclear energy contend that inexpensive natural gas has dramatically slowed development of these cleaner energy resources. A few years ago many thought that nuclear energy was on the cusp of a renaissance, as the Nuclear Regulatory Commission entertained applications for new plants for the first time in decades. However, optimism has waned as investors worried about the ability of nuclear power to compete with cheap natural gas fired electricity. For their part, wind and solar generation continue to grow,[116] in part because the marginal costs of producing electricity from those sources is nearly zero,[117] meaning that wind and solar power tend to be dispatched to the grid (and therefore purchased) whenever they are available. Furthermore, the total cost of generating electricity from these sources has continued to decline, and tax credits and renewable portfolio standards seem likely to continue to preserve (or drive) the market for wind and solar power. On the other hand, wind and solar are intermittent resources, and must be supported by some combination of more reliable generating technologies, demand reduction, or electricity storage during those times when the wind is not blowing or the sun is not shining. Right now, the most cost-competitive of these support options is natural gas-fired power.[118]

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116. *See* RON PERNICK ET AL., CLEAN EDGE, CLEAN ENERGY TRENDS 2012 (2012), http://www.cleanedge.com/sites/default/files/CETrends2012_Final_Web.pdf; *see also* Toby D. Couture, & David Jacobs, *The Future of Electricity Markets*, RENEWABLE ENERGY WORLD (Feb. 18, 2013), http://www.renewableenergyworld.com/rea/news/article/2013/02/the-future-of-electricity-markets.

117. Couture & Jacobs, *supra* note 116.

118. Combined cycle natural gas turbines ramp up and down more efficiently than coal-fired or nuclear plants, and are cheaper than batteries, pumped-storage hydro, flywheels, compressed air, or other forms of energy storage to complement wind and solar. For a fuller discussion of this intermittency problem, see David B. Spence, *Regulation, Climate Change, and the Electric Grid*, 3 SAN DIEGO J. CLIMATE & ENERGY L. 267, 288–92 (2011–12).

However, many people aspire to an energy future free of fossil fuels, in which the problem of intermittency that afflicts wind and solar power has been overcome. Some may see natural gas as a bridge to that future, but only a bridge; they worry that gas has become so inexpensive that it is deterring progress toward the ultimate goal of a renewables-based energy mix. That logic works only in the very long term, however, and seems likely to ignore more pressing (and environmentally significant) tradeoffs. Right now, an even more important energy marketplace dynamic is the competition between natural gas and coal in the electric generation system. The ongoing scientific debate over the long-term climate impacts of increased natural gas production (described in Part I) focuses on this a very dynamic, but only on its climate impacts. Because natural gas-fired power plants produce much less carbon dioxide than coal-fired plants,[119] the displacement of coal by natural gas in the electric generation sector in recent years is apparently yielding climate benefits, according to the International Energy Agency.[120] However, *if* fugitive methane emissions from natural gas production are sufficiently high, *and if* those fugitive emissions cannot be controlled economically, increased natural gas production may yield no climate benefits at all; to the contrary, it may exacerbate climate change. No credible sources are making that claim just yet, but combatants in the fracking debate have seized on the scholarly disagreement over the rate of leakage to argue the climate change merits of replacing coal with natural gas in our energy mix. If policymakers are to craft regulation that maximizes the net benefits of natural gas production, they will need to rely on good scientific analyses of the methane leakage issue, and good information about the costs of addressing it. No consensus yet exists on those issues.

Of course, our relative use of different fuels has environmental and health consequences beyond those associated with climate change. Indeed, climate issues aside, the displacement of coal-fired electric generation by natural gas-fired generation seems likely to yield enormous public welfare benefits. Indeed, when scholars try to quantify the health impacts (premature deaths, illness, and injuries)

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119. *Natural Gas: Electricity from Natural Gas*, EPA http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html (last updated Sept. 25, 2013).

120. *See* Chazan, *supra* note 35 and accompanying text.

from coal extraction, processing, transport, and combustion, the results border on shocking. A 2009 National Academy of Sciences study estimated the annual *non-climate* related external damages from 406 coal-fired power plants to be $62 billion, or about 3.2 cents per kwh, representing about thirty to fifty percent of the average cost of electricity.[121] A recent study reported in the *Annals of the New York Academy of Sciences*[122] (a multidisciplinary scientific journal), examined the health effects of the coal industry on a lifecycle basis. The authors, who comprise of researchers from various public health and academic institutions,[123] estimated that these externalities cost the American public as much as half a *trillion* dollars each year,[124] and "conservatively" estimated that if these costs were internalized the price of electricity generated from coal would "double or triple."[125] Another recent study, reported in the *American Economic Review*, developed a framework for comparing (quantifying) the damages associated with non-greenhouse gas air pollution emissions from 820 industries (including all of the major polluting industries) with the value added to the economy by those industries.[126] The authors concluded that the net benefits[127] of seven of those industries (including oil- and coal-fired power plants, but not natural gas-fired

121. News Release, Nat'l Academy Of Sci., Report Examines Hidden Health and Environmental Costs of Energy Production and Consumption in U. S. 1 (Oct. 19, 2009), http://www.usclimatenetwork.org/resource-database/NAS%20study%20on%20costs%20of%20energy.pdf.

122. Melissa M. Ahern et al., *Full Cost Accounting for the Life Cycle of Coal*, *in* 1219 ECOLOGICAL ECON. REVIEWS 73 (Robert Costanza et al. eds., 2011).

123. These included the Harvard Medical School, the Harvard School of Public Health, the Boston University School of Public Health, the Department of Pharmacology at Washington State University, and the Department of Community Medicine at West Virginia University.

124. Paul R. Epstein et al., *Full Cost Accounting for the Life Cycle of Coal*, 1219 ANNALS N.Y. ACAD. SCI., 73, 73 (2011), http://solar.gwu.edu/index_files/Resources_files/epstein_full%20cost%20of%20coal.pdf.

125. *Id.* at 93

126. Robert Mendelsohn et al., *Environmental Accounting for Pollution in the United States Economy*, 101 AM. ECON. REV. 1649 (2011), *available at* http://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.101.5.1649.

127. More precisely, the authors expressed the results in terms of net costs—the ratio of environmental damages to value added for each industry. *See id.* at 1665.

power plants) were negative.[128] The authors concluded further that coal-fired combustion created by far the largest amount of environmental damage, which they estimated at approximately $53 billion per year.[129] By contrast, they estimated environmental damages from natural gas-fired production to be less than $1 billion per year.[130] The authors estimated the environmental costs of coal-fired generation to be approximately 2.8 cents per kilowatt hour (cents/kwh), from oil-fired generation to be two cents/kwh, and from natural gas-fired generation to be approximately 0.1 cents/kwh.[131]

This literature suggests that the bulk of the harm caused by coal combustion is attributable to mortality resulting from emissions of conventional air pollutants, primarily sulfur dioxide, fine particles, and nitrogen oxides. By comparison, environmental harm from greenhouse gas emissions pales in comparison, representing well under one percent of the harm estimated in the *American Economic Review* analysis. Other studies have reached similar conclusions,[132] and offer further support for the notion that coal combustion imposes very large mortality, morbidity and environmental costs on American society, costs that dwarf those associated with natural gas-fired

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128. *See Id.* The ratio of environmental damage to value added was higher for oil-fired generation (5.13) and from coal-fired generation (2.20), and higher still for solid waste combustion and incineration (6.72). However, the ratio for natural gas-fired generation was less than .10, denoting a positive and if the cost ratio for that industry. *Id.* at 1664.

129. *Id.* at 1667. The next largest amount of environmental damage was associated with the livestock production industry, at $14.8 billion. *Id.* at 1665. Since the authors did not report the environmental damage number for natural gas-fired power production, it must be less than $4 billion per year. *Id.*

130. *Id.* at 1669.

131. *Id.*

132. Studies of the effects of coal on the states of Kentucky and West Virginia concluded that the net benefits of coal to their states were negative. *See, e.g.*, Melissa Fry Konty & Jason Bailey, *The Impact of Coal on the Kentucky State Budget*, MOUNTAIN ASS'N FOR CMTY. ECON. DEV. 2 (2009) http://www.maced.org/coal/documents/Impact_of_Coal-Exec_Summary.pdf. A study by the West Virginia Center. For Budget and Policy and the Consulting Firm Downstream Strategies reached a similar conclusion about the effects of coal on the West Virginia state budget. *See Researchers Push for Higher Taxes, Fees, Fines on Coal*, ASSOCIATED PRESS (Sept. 13, 2010), *available at* http://www.wvgazette.com/News/201009130914.

power.[133] These represent the benefits of increased reliance on natural gas or electric power generation, and the opportunity costs of any regulatory decisions that increase the relative cost of natural gas has against coal.

When discussing responsible shale gas production, we neglect these opportunity costs at our peril. Any clear eyed assessment of the relative benefits and costs of shale gas production (and, correspondingly, shale gas regulation) ought to include consideration of these opportunity costs. Such an analysis is possible, in theory, given reliable information about the costs and benefits of shale gas production and other fuels. However, the point made by James Madison in the quotation at the start of this essay suggests a problem long understood by philosophers—namely, that our self-interest clouds our ability to assess risks objectively. The uneven distribution of the costs and benefits of fracking produces diverging understandings of the magnitude of those costs and benefits, making risk assessment difficult in practice. Recent work in the behavioral sciences explains why that is in ways reminiscent of James Madison's language in Federalist No. 10.

B. Policymaking and the Behavioral Side of the Fracking Debate

It was psychologist Leon Festinger who coined the term *cognitive dissonance*[134] to describe the psychological discomfort we feel when we are presented with two conflicting cognitions, or beliefs. We use the companion term *rationalization* to describe the mental tricks we play on ourselves in order to relieve that discomfort. At its simplest level, rationalization can influence the fracking debate in straightforward, almost obvious ways. For example, if I work for a natural gas company and derive economic and psychological benefits from my job, the notion that my work poses environmental risks to others will produce cognitive dissonance. I would be much more comfortable if my efforts to produce shale gas benefited not only me, but also society as a whole; therefore, I am motivated to conclude

133. *See* Nat'l Acad. of Sci., *supra* note 121, at 2 ("burning natural gas generated far less damage than coal, both overall and per kilowatt-hour of electricity generated.").

134. *See generally* LEON FESTINGER, A THEORY OF COGNITIVE DISSONANCE 137–42 (1957).

that the net social benefits of fracking are positive. Correspondingly, if I would prefer not to endure the disruptions and risks associated with fracking on my neighbors' property, the notion that fracking is generally safe or provides environmental benefits to others produces cognitive dissonance. I would be much more comfortable if my efforts opposing fracking benefited not only me, but also society as a whole; therefore, I am motivated to conclude that the net social benefits of fracking are negative.

Recent research within the fields of psychology, anthropology, and neurobiology has gone well beyond the simple notion of rationalization, revealing much more about when, why, and how rationalizations occur. Under the banner of "behavioralism," this research has made significant inroads into legal scholarship and economics;[135] indeed, Daniel Kahneman received the Nobel Memorial Prize in Economic Sciences award in 2002 for his work with Amos Tversky identifying systematic human decision-making heuristics and biases.[136] For our purposes, several ideas drawn from this research have contributed to our understanding of behavioral phenomena that help explain not only the polarization of the fracking debate, but also reasons why that polarization can interfere with reasoned policymaking. Because shale gas production policy creates winners and losers (no matter what the policy choice), the losers may seek redress from the government—i.e., judges, regulators, or legislators. As policymakers consider their options, they should beware of the ways in which heuristics and biases can interfere with developing a clear-eyed understanding of what we know, and that

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135. For example, see the work of Jeff Rachlinski. Jeffrey J. Rachlinski & Forest Jourden, *The Cognitive Components of Punishment*, 88 CORNELL L. REV. 457 (2003); Jeffrey J. Rachlinksi, *The Psychology of Global Climate Change*, 2000 U. ILL. L. REV. 299; Chris Guthrie, Jeffrey J. Rachlinski, & Andrew Wistrich, *Judging by Heuristic Cognitive Illusions in Judicial Decision Making*, 86 JUDICATURE 44 (2002). *See also* the work of Cass Sunstein with various co-authors, including RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS (2008) (summarizing and expanding upon earlier articles applying behavioralism to legal topics).

136. This work comprises a large number of scholarly papers on the psychology of choice, many arising from experiments. For a good example of this work (and one that subsumes more than one such experiment), see Amos Tversky & Daniel Kahneman, *Judgment under Uncertainty: Heuristics and Biases*, 185 SCI. 1124 (1974).

which we do *not* know, about fracking. Specifically, because policymaking is subject to political pressures, policymakers must beware of the tendency of policy combatants toward bias in assimilating new information about fracking.

In a perfectly rational world, one might hypothesize that as we learn more about the effects of fracking, rational, unbiased decision makers on all sides of the fracking issue—whatever their value differences—will converge upon a common understanding of the environmental and health effects of shale gas production.[137] In the language of Bayesian[138] decision-making, when confronted with new information that is consistent with hypothesis *H1*, our estimate of the probability that *H1* is true ought to increase, or at least ought not to decrease.[139] By that logic, as we develop a fuller record of the effects of fracking, remaining disagreements about policy ought to be based more and more on value differences (such as disagreement over the relative importance of climate effects, jobs, etc.) rather than on disagreements over the factual predicates of a policy decision. However, behavioral research suggests that that sort of convergence around certain empirical truths will not happen; to the contrary, it is likely that combatants in the fracking debate will instead harden their beliefs as the factual record develops, in part by assimilating new information about the effects of shale gas production in biased ways.

Confirmation bias refers to the notion that people are motivated to defend and protect cherished beliefs, and so will assimilate and interpret new information in ways that protect those beliefs. One scholar has described this process as a kind of unconscious analog to the process trial lawyers go through when building a case—a kind of "unwitting selectivity in the acquisition and use of evidence."[140] The phenomenon has been recognized by the discipline of psychology

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137. *See e.g.*, DEBATING DELIBERATIVE DEMOCRACY (James S. Fishkin & Peter Laslett eds., 2003). This is part of the rationale for the notion of "deliberative democracy," an idea championed by political scientist James Fishkin. *Id.*

138. Bayesian reasoning involves the way we make decisions under uncertainty, and how we might logically update beliefs about uncertain facts in the face of new information.

139. For a detailed discussion of Bayesian probability theory, *see Bayes' Theorum*, STAN. ENCYCLOPEDIA OF PHIL., http://plato.stanford.edu/entries/bayes-theorem (last updated June 28, 2003).

140. Raymond S. Nickerson, *Confirmation Bias: A Ubiquitous Phenomenon in Many Guises*, 2 REV. GEN. PSYCHIATRY 175, 175 (1988).

since at least 1924, and has since been documented through experiments in countless forms.[141] For example, experimental subjects repeatedly recall evidence supporting their pre-existing beliefs better than they recall contradictory evidence.[142] Indeed, we are motivated to confirm even unsupported hypotheses: experimental subjects given a hypothesis in the absence of evidence require less supportive evidence to confirm that hypothesis than contradictory evidence to reject it.[143] Not only that, subjects sometimes interpret contradictory evidence as supportive of their beliefs;[144] in one experiment subjects who supported the death penalty concluded from a scholarly article on the subject that it did also, while readers who opposed the death penalty drew the opposite conclusion from the very same article.[145]

Thus, proponents of fracking can be supremely confident that the practice has *never* contaminated drinking water sources, despite the EPA's conclusions about contamination at Pavilion, Wyoming or producers' decisions to settle contamination lawsuits. At the same time, opponents of fracking remain equally confident that it *inevitably* leads to drinking water contamination, despite the various academic studies indicating that contamination is likely very rare.[146] Moreover, proponents and opponents alike cite the same anecdotes

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141. *See id.* Nickerson calls confirmation bias so "sufficiently strong and pervasive that one is led to wonder whether the bias, by itself, might account for a significant fraction of the disputes, altercations, and misunderstandings that occur among individuals, groups, and nations." *Id.*

142. *See generally* D.N. Perkins, Richard Allen & James Hafner, *Difficulties in Everyday Reasoning*, *in* THINKING: THE EXPANDING FRONTIER 177 (William Maxwell ed., 1983); D.N. Perkins et al., *Everyday Reasoning and the Roots of Intelligence*, *in* INFORMAL REASONING AND EDUCATION 83 (James F. Voss et al. eds., 1991).

143. *See* Tom Pyszczynski & Jeff Greenberg, *Toward an Integration of Cognitive and Motivational Perspectives on Social Inference: A Biased Hypothesis-Testing Model*, 20 ADVANCES EXPERIMENTAL SOC. PSYCHOL. 297 (1987).

144. Gordon F. Pitz et al., *Sequential Effects in the Revision of Subjective Probabilities*, 21 CANADIAN J. OF PSYCHOL. 381 (1967).

145. Charles G. Lord et al., *Biased Assimilation and Attitude Polarization: The Effects of Prior Theories on Subsequently Considered Evidence*, 37 J. PERSONALITY & SOC. PSYCHOL. 2098, 2108 (1979).

146. *See* discussion of the scientific literature on water contamination, *supra* notes 84–88, and accompanying text.

(such as the EPA's investigation of water contamination in Dimock, Pennsylvania, or the Dunkard Creek incident in West Virginia) and studies (such as the Duke study)[147] in support of their groundwater contamination claims. We see this same dynamic at work in the debate over the climate and economic effects of shale gas production as well.

Confirmation bias is about defending one's *beliefs*: once we form a belief, we assimilate new information in a biased fashion thereafter.[148] This gives rise to something called "the primacy effect," the idea that we give more weight to the information we receive first about a particular issue than to information we receive later.[149] This is apparently true irrespective of the truth or falsity of the underlying belief.[150] Stated differently, first impressions are durable. If one's first exposure to information about fracking is favorable—say, because one works for the industry or has a friend who does—one's initial beliefs about the relative benefits of shale gas production will likely be very different from the initial beliefs formed by someone whose first exposure to the issue was viewing *Gasland*, for example.

A closely related but conceptually distinct alternative explanation for biased assimilation comes from anthropology. According to this view, we disagree about the empirical dimensions of important policy questions not because we lack balanced information about those questions, but because our prior "cultural commitments" shape our

147. *See supra* note 87, and accompanying text.

148. *See, e.g.*, Pitz et al., *supra* note 144; Nickerson, *supra* note 140, at 177 ("The evidence also supports the view that once one has taken a position on an issue, one's primary purpose becomes that of defending or justifying that position.").

149. *See* Philip E. Tetlock, *Accountability and the Perseverance of First Impressions*, 46 SOC. PSYCHOL. Q. 285, 286 (1983).

150. One study noted in pertinent part:

> It is natural to associate the confirmation bias with the perseverance of false beliefs, but in fact the operation of the bias may be independent of the truth or falsity of the belief involved. Not only can it contribute to the perseverance of unfounded beliefs, but it can help make beliefs for which there is legitimate evidence stronger than the evidence warrants. Probably few beliefs of the type that matter to people are totally unfounded in the sense that there is no legitimate evidence that can be marshaled for them. On the other hand, the data regarding confirmation bias, in the aggregate, suggest that many beliefs may be held with a strength or degree of certainty that exceeds what the evidence justifies.

Nickerson, *supra* note 140, at 188.

beliefs about those underlying empirical facts.[151] In other words, we are each psychologically committed to our own social identity, which in turn is tied to our group memberships, our ideology, etc. Our commitments to those identities "operate as a kind of heuristic" that prevents the rational processing of information on public policy matters.[152] In particular, this dynamic distorts our perceptions of risk, making us far more amenable to new information about risk that is consistent with our cultural identity. We rely on experts, but we only trust those experts who "share our values;" and we assess whether an expert shares our values based, in part, on the content of the expert's opinion.[153] This is a phenomenon that Dan Kahan and his colleagues at the Yale Law School's Cultural Cognition Project call the "cultural cognition of risk."[154]

Kahan and others have demonstrated the biased assimilation of expert information based upon political ideology[155] across a number of public policy issue contexts, including gun control,[156] the death penalty,[157] the safety of nuclear power,[158] and more. This cultural cognition phenomenon is particularly pronounced where

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151. *See* Dan M. Kahan & Donald Braman, *Cultural Cognition and Public Policy*, 24 YALE L. & POL'Y REV. 147, 148 (2006).

152. *Id.* at 149. Note that this phenomenon does not imply duplicity, but rather the same kind of unconscious case-building described by Nickerson, albeit for a slightly different reason. *Id.*

153. *Id.*

154. *Id.*

155. *See, e.g.*, *id.* at 151. The authors' measure of ideology is based upon the "group-grid" typology developed by political scientist Aaron Wildavsky, which classifies ideological preferences along two dimensions: the group dimension (individualist versus communitarian), and the grid dimension (hierarchist versus egalitarian). Wildavsky (and, by extension, Kahan & Braman) ascribe left-wing ideology to egalitarian communitarians, and right-wing ideology to hierarchical individualists. *See also* Dan M. Kahan et al., *Cultural Cognition of Scientific Consensus*, 14 J. OF RISK RES. 147 (2010).

156. *See* DAN M. KAHAN ET AL., THE SECOND NATIONAL RISK AND CULTURE STUDY: MAKING SENSE OF—AND MAKING PROGRESS IN—THE AMERICAN CULTURE WAR OF FACT 8 (2007).

157. *See* Phoebe C. Ellsworth & Samuel R. Gross, *Hardening of the Attitudes: Americans' Views on the Death Penalty*, 50 J. SOC. ISSUES 19 (1994); *see also* Samuel R. Gross, *Update: American Public Opinion on the Death Penalty—It's Getting Personal*, 83 CORNELL L. REV. 1448 (1998).

158. *See* KAHAN ET AL., *supra* note 156, at 4–6.

environmental risks are involved because the question of whether the government ought to act to reduce risk invokes fundamental elements of one's political ideology and, therefore, one's identity.[159] Most recently, Kahan et al. demonstrated that biased assimilation occurs even when subjects are presented with evidence of a scientific consensus about the empirical facts in question. In one study, researchers presented subjects with evidence of a national scientific consensus[160] supporting two propositions: (i) that climate change is real and driven by human activity, and (ii) that nuclear waste can be safely disposed of in a geological repository. When asked to rate the credibility of the experts supporting these propositions, political conservatives rated the credibility of the climate change experts much less highly than the nuclear waste disposal experts, while political liberals reversed those rankings.[161]

Thus, combatants in the fracking debate assimilate new information about the risks of shale gas production in ways that are most consistent with their sense of their individual identities, and they work to discredit the authors of studies reaching conclusions contradicting their positions. Anti-fracking activists have challenged two of the studies finding no connection between groundwater contamination and fracking, one from Penn State University[162] and another from the University of Texas.[163] In both cases, critics alleged

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159. *See* Kahan et al., *supra* note 155, at 152 ("Egalitarians and [communitarians] are thus naturally sensitive to environmental risk, the reduction of which justifies regulating commercial activities that are productive of social inequality and that legitimize unconstrained self-interest. Individualists predictably dismiss claims of environmental risk as specious, in line with their commitment to the autonomy of markets and other private orderings."). *See also* MARY DOUGLAS & AARON WILDAVSKY, RISK AND CULTURE: AN ESSAY ON THE SELECTION OF TECHNICAL AND ENVIRONMENTAL DANGERS (1982) (exploring this phenomenon).

160. *See* Kahan, et al., *supra* note 155, at 152. These propositions were selected because the National Academy of Sciences had issued reports supporting both. *Id.*

161. *Id.* at 165.

162. ELIZABETH W. BOYER ET AL., THE IMPACT OF MARCELLUS GAS DRILLING ON RURAL DRINKING WATER SUPPLIES, CTR. FOR RURAL PENN. (2011), http://www.rural.palegislature.us/documents/reports/Marcellus_and_drinking_water_2011_rev.pdf.

163. CHARLES P. GROAT & THOMAS W. GRIMSHAW, FACT-BASED REGULATION FOR ENVIRONMENTAL PROTECTION IN SHALE GAS DEVELOPMENT, U. TEX. ENERGY INST. (2012), *available at* http://www.slideshare.net/MarcellusDN/factbased-

that the studies' conclusions were driven by connections between the university and industry.[164] Similarly, industry critics have challenged a Cornell University study—which found higher levels of natural gas in groundwater near natural gas production wells—on similar grounds, alleging that the study's conclusions were influenced by one of its funders.[165]

It may be that biased assimilation is facilitated by our brains' tendency to invent taxonomies to organize information about the world; once created, we assimilate new information in ways that fit those taxonomies.[166] Alternatively, Kahan et al. has labeled this "narrative framing," explaining in pertinent part:

> [I]ndividuals tend to assimilate information by fitting it to pre-existing narrative templates or schemes that invest the information with meaning. The elements of these narrative templates—the identity of the stock heroes and villains, the nature of their dramatic struggles, and the moral stakes of

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regulation-for-environmental-protection-in-shale-gas-development. The study was later withdrawn by the University of Texas.

164. Critics have condemned the Penn State University study as industry-funded and led by a pro-industry academic. *See* Jim Efstathiou Jr., *Frackers Fund University Research that Proves Their Case*, BLOOMBERG (July 23, 2012, 11:52 AM), http://www.bloomberg.com/news/2012-07-23/frackers-fund-university-research-that-proves-their-case.html. With regard to the University of Texas study, an internal university review found that the principal investigator had failed to disclose his membership on the board of directors of an oil and gas company; however, the internal review ultimately determined that the conclusions contained in the issue papers comprising the study (none of which were authored by the principal investigator) were not undermined by the principal investigator's industry connection. *Id.*

165. *See* Mike Soraghan, *Quiet Foundation Funds the 'Anti-Fracking' Fight*, E&E PUB. (Mar. 12, 2012), http://www.eenews.net/public/energywire/2012/03/12/1.

166. Nickerson calls this "reification." *See* Nickerson, *supra* note 140, at 183 ("Taxonomies that are invented as conceptual conveniences often come to be seen as representing the way the world is really structured. Given the existence of a taxonomy, no matter how arbitrary, there is a tendency to view the world in terms of the categories it provides.").

> their engagement with one another—vary in identifiable and recurring ways across cultural groups.[167]

It is easy to see how this kind of framing might influence our assimilation of new information about shale gas production. There is a long history of framing political conflict over energy policy as "energy versus the environment," "people versus profits," and "fossil fuels versus clean energy." Often, these kinds of associations are not conscious choices; to the contrary, they are a function of how the human brain stores (and recalls) information.[168]

When proponents of shale gas production tout the environmental benefits of clean, inexpensive natural gas, they are running headlong into those framing effects. The environmental battles of the past often pitted the forces of environmentalism against the "fossil fuels" industry, creating associations in our minds between coal, oil and gas that impede the efforts of fracking's proponents to draw environmental distinctions between those fuels. Thus, for example, climate change activist Bill McKibben perceives no real distinction between "hydrocarbons;" instead, McKibben simply advocates for a move away from all of them, since "getting at them requires ripping apart the earth . . . ."[169] Similarly, fracking proponents may also be fighting some people's associations between oil and gas companies, on the one hand, and pollution, on the other. When the brain stores information from news stories about the Exxon Valdez accident and the Deepwater Horizon spill, it may develop neural connections between the parts of the brain that store information about oil and gas companies and those storing information about pollution. Those connections, in turn, influence how we process (credit or discredit) subsequent information we encounter about, say, natural gas.

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167. Kahan et al., *supra* note 155, at 170.

168. *See, e.g.*, DEAN BUONOMANO, BRAIN BUGS: HOW THE BRAIN'S FLAWS SHAPE OUR LIVES 141 (2011) ("[W]e are all too well prepared to learn to fear through observation . . . . Because vicarious learning is in part unconscious, it seems to be partially resistant to reason and ill-prepared to distinguish fact from fiction.").

169. Bill McKibben, *Why Not Frack?*, N.Y. REV. OF BOOKS (Mar. 8, 2012), *available at* http://www.nybooks.com/articles/archives/2012/mar/08/why-not-frack.

Moreover, this effect is particularly powerful when fear is involved, because the fear circuitry of the brain can override reason. Neurobiologist Dean Buanomano calls this "amygdala politics,"[170] and warns that "we should be most concerned about how vulnerabilities in our fear circuits are exploited by others."[171] Indeed, the brain's fear circuitry (the amygdala) has greater influence on the brain's reasoning centers (the cortex) than the cortex has on the amygdala, allowing emotion to override reason in decision-making when emotion is invoked.[172] Appeals to fear, then, can be effective tools in the battle over public opinion. In particular, local NIMBY (not in my backyard) opposition to fracking seems consistent with amygdala politics. The probability that one's drinking water well will be contaminated by fracking nearby may be low, but the harm (if it does occur) is great, invoking the brain's fear centers. Furthermore, even if the probability of contamination is low, the fear is real, and NIMBY opposition may be entirely rational.

Of course, this research is merely providing scientific underpinnings for ideas philosophers have long recognized. Machiavelli advised princes on the use of fear for political ends 400 years ago, and we have already noted one American founder's familiarity with the power of rationalization and biased assimilation.[173] Unfortunately, we seem to be more aware of these dynamics in others than in ourselves.[174] I may understand that your opposing beliefs about empirical facts are sincerely held, but I attribute them to your bias while ascribing objectivity to my own

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170. BUANOMANO *supra* note 168 at 138 (citing the work of Joe LeDoux.)

171. *Id.*

172. JOSEPH E. LEDOUX, THE EMOTIONAL BRAIN: THE MYSTERIOUS UNDERPINNINGS OF EMOTIONAL LIFE 303 (1998).

173. NICCOLÒ MACCHIAVELLI, THE PRINCE (Phillip Smith ed. 1992).

174. The "fundamental attribution error" is the human tendency to attribute causes of bad behavior to actors' internal, dispositional factors rather than situational pressures. In other words, we tend to explain our own actions as a product of an internal narrative that almost always includes good intentions; but we explain others' actions without the benefit of their internal narratives, and so we are quicker to include selfish or bad intentions in those explanations. *See generally* MAX H. BAZERMAN & ANN E. TENBRUNSEL, BLIND SPOTS: WHY WE FAIL TO DO WHAT'S RIGHT AND WHAT TO DO ABOUT IT (2011).

beliefs.[175] You will likely do the same for me. This problem is particularly acute within groups, where we sometimes succumb to "naïve realism," or the human tendency to view in-group factual beliefs as "objective" and out-group beliefs as subject to biases.[176] Naïve realism is a modern relative of "groupthink," which psychologist Irving Janis has defined as "a mode of thinking that people engage in when they are deeply involved in a cohesive in-group, when the members' strivings for unanimity override their motivation to realistically appraise alternative courses of action."[177] More recently, Tim Kuran has documented what he calls "preference falsification," the tendency of individuals to tailor their choices to what appears to be socially acceptable within a group.[178] In any case,

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175. Nickerson argues that confirmation bias is stronger and more pronounced in heated arguments:

> [C]an anyone doubt that whenever one finds oneself engaged in a verbal dispute it becomes very strong indeed? In the heat of an argument people are seldom motivated to consider objectively whatever evidence can be brought to bear on the issue under contention. One's aim is to win and the way to do that is to make the strongest possible case for one's own position while countering, discounting, or simply ignoring any evidence that might be brought against it.

Nickerson, *supra* note 140, at 205.

176. Kahan et al., *supra* note 155, at 164.

177. IRVING L. JANIS, VICTIMS OF GROUPTHINK: A PSYCHOLOGICAL STUDY OF FOREIGN-POLICY DECISIONS AND FIASCOES 9 (1972). In other words, in order to be "team players" and "go with the flow," members of groups are prone to signing off on group decisions that they would never have made individually. The space shuttle Challenger disaster and the Kennedy Administration's Bay of Pigs fiasco have been cited as examples of the potentially disastrous consequences of groupthink. When later interviewed individually, members of the Kennedy administration all claimed that they had severe qualms about the ill-fated invasion to overthrow Castro, but said that they thought they might be the only person in the room not in agreement with the plan. Therefore, to enhance group solidarity, they all chose to appear just as confident in the plan's ultimate favorable outcome as the others appeared to be. *See also* ROBYN M. DAWES, EVERYDAY IRRATIONALITY: HOW PSEUDO- SCIENTISTS, LUNATICS, AND THE REST OF US SYSTEMATICALLY FAIL TO THINK RATIONALLY 152 (2002).

178. *See* TIMUR KURAN, PRIVATE TRUTHS, PUBLIC LIES: THE SOCIAL CONSEQUENCES OF PREFERENCE FALSIFICATION 3 (1997) (describing "preference

it seems that initial beliefs are strengthened (and insulated from challenge) within homogeneous groups.[179] In this way, both pro- and anti-fracking groups exacerbate the biased assimilation of information, further widening the gulf of perception between them.

Hence the growing polarization between combatants in the debate over shale gas production, even as the scientific community builds a more careful and circumspect view of the relative risks of fracking.[180]

CONCLUSION: COOL ANALYSIS AND FRACKING POLICY

So what, then, is a policymaker to do? Policymakers need to be aware of the centrifugal forces at work in the shale gas policy debate, forces that are exacerbated by combatants who are deeply entrenched in their positions. Recently, Bill Gates, speaking about the climate change debate, lamented that "extreme views get more attention than nuanced views," despite scientists best efforts to be clear and impartial.[181] Gates blamed "both liberals and conservatives" for making it difficult for the general public to understand the nuances.[182] Regardless, policymakers should not expect already-hardened positions to soften, no matter how the evidentiary record develops. Of course, shale gas policy decisions implicate important environmental and economic values, and policymakers should not pretend otherwise. However, ideally, policymakers will base their decisions on a clear-eyed view of the facts. In the face of political

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falsification" as "the act of misrepresenting one's genuine wants under perceived social pressures.").

179. *See, e.g.*, Cass R. Sunstein, *Deliberative Trouble? Why Groups Go to Extremes*, 110 YALE L.J. 71, 105–11 (2000).

180. Recently, the think tank Resources for the Future surveyed experts on the risks of fracking. The experts identified twelve "consensus risks" associated with fracking, ten of which are common to other forms of natural gas development. *See* ALAN KRUPNICK, HAL GORDON & SHEILA OLMSTEAD, RESOURCES FOR THE FUTURE, PATHWAYS TO DIALOGUE: WHAT THE EXPERTS SAY ABOUT THE ENVIRONMENTAL RISKS OF SHALE GAS DEVELOPMENT 18–19 (2013), http://www.rff.org/Documents/RFF-Rpt-PathwaystoDialogue_FullReport.pdf.

181. *See e.g.*, Benny Peiser, *Solar Activity Weakest In A Century*, CLIMATE CHANGE DISPATCH (Dec. 16, 2013), http://www.climatechangedispatch.com/11960-solar-activity-weakest-in-a-century.html. Bill Gates made these observations in the course of reviewing a book on resource scarcity issues.

182. *Id.*

pressure, it is difficult to cut through the moral outrage and focus on cool analysis. However, there are ways to structure policy deliberations so as to minimize the effect of centrifugal forces on policy decisions.

Policymakers will make better decisions about fracking and shale gas production if they rely on the scientific literature, taking the claims promulgated by industry and anti-fracking activists with a grain of salt. Even though scientists and academics are not immune to the biases described in the previous section,[183] they are still subject to methodological norms that privilege the null hypothesis, impose a duty of circumspection on their conclusions, and subject their conclusions to peer review and challenge. All of these forces tend to make the growing corpus of scientific literature on fracking and shale gas production far more important to the goal of good policymaking than the anecdotes, stories, and hyperbolic claims of combatants in the policy debate. More specifically, policymakers can use the scientific literature in the following ways.

First, *policymakers must recognize that the scientific debate is focused on much narrower issues than the policy debate*. The combatants in the policy debate are driving toward predetermined conclusions—i.e., "fracking is good" or "fracking is bad." Consequently, the combatants minimize or deny even obvious truths, and reflexively challenge contributions to the scientific literature, which contradict their points of view. Scientists, by contrast, do not dispute the central truths about shale gas production outlined above in Part I.A. They acknowledge that shale gas production imposes real costs on local communities—such as noise, truck traffic, "boomtown" effects, and other indicia of industrialization during the period when a well is being "fracked." At the same time, scientists recognize that shale gas production brings real local economic benefits—including jobs and local government revenues during the production period. The scientific debate is thus focused on specific questions, such as the magnitude of the risks to groundwater posed by shale gas production, or the amount of methane that escapes from natural gas wells and production equipment. Combatants in the

183. *See generally* Nickerson, *supra* note 140, at 189 ("Experts are not immune from the illusion of validity . . . [but nevertheless] appear to do better when there is a reliable basis for statistical prediction . . . .").

policy debate sometimes try to misrepresent the results of such scholarly studies, presenting their implications as much broader than they actually are.

For example, as noted above in Part I, the authors of the Duke University study found no evidence that groundwater quality near natural gas production wells in the Marcellus Shale had been impaired by natural gas operations; but they *did* find evidence that deep, thermogenic methane and brines had found their way into shallow groundwater sometime prior to the commencement of their study.[184] Industry advocates seized upon the study's first finding to support their claim that fracking does not threaten groundwater, while anti-fracking advocates focused on the latter finding, which they claimed indicated the presence of a tangible risk to groundwater.[185] Indeed, viewed as a whole, the scholarly literature on groundwater contamination from shale gas production activities points toward a truth somewhere in the middle—namely, that the risk of groundwater contamination is greater than zero, but very small. Several studies—including the Duke study and the most recent USGS study[186]—sampling groundwater near hundreds of natural gas production wells before and after production activities in several different regions have failed to detect evidence of contamination by fracking. By the same token, it is equally clear that contamination is possible due to poor handling of fluids at the surface or failure to properly construct or seal natural gas wells. These kinds of failures may be the cause of the Wyoming and Pennsylvania contamination incidents described above in Part I. In any event, natural gas production companies have fracked many tens of thousands of wells in the last five years, and assuming normal rates of human error, it would defy logic to suggest that the risk of groundwater contamination associated with fracking is zero.

Second, in order to try to insulate policy decisions from the centrifugal forces present in the political debate, *elected politicians should delegate to unelected bureaucrats the responsibility of developing the factual record* underlying policy decisions.

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184. *See* Osborn et al., *supra* note 87, at 8174–75; *supra* text accompanying notes 87–88.

185. For a good discussion of the misuse of science in the fracking debate, see Begos, *supra* note 22.

186. *See* Kresse et al., *supra* note 91.

Combatants in the fracking policy debate will place tremendous pressure on elected officials. Industry has the economic resources to influence elected politicians through campaign contributions and issue campaigns; anti-fracking activists can use celebrity star power and moral outrage to bring indirect electoral pressure on elected politicians. For reasons outlined in Part II of this essay, any decision-maker subject to this kind of pressure is prone to biased assimilation of the data. By insulating decision-makers from that sort of direct pressure, policymakers will develop a more accurate factual foundation for their decisions. For example, as of this writing, the states of New York, Maryland, and New Jersey are each involved in a protracted decision process in which elected leaders have imposed moratoria on shale gas development pending completion of impact studies led by panels of unelected experts. This approach may seem painful and slow, but there may be a method to the madness: it may constitute a way for elected politicians to create a more accurate and factual record on which to base their decisions.

Third, *policymakers should avoid staking out positions prior to making formal policy decisions*. Policymakers might stake out a position "too early" by committing to specific positions in meetings with combatants in the fracking policy debate, or by taking positions in interviews or speeches. The confirmation bias phenomenon tells us that once taken, we resist moving off of those initial positions irrespective of how the factual record develops subsequently. Our understanding of the cultural cognition of risk tells us that our view of the facts is conditioned by our sense of identity, and the groups to which we belong. By keeping constituent groups at arm's length on this issue before rendering a policy decision, policymakers can try to mitigate the effects of these biases. Thus, for example, by remaining noncommittal about the ultimate decision, Governor Cuomo of New York and Governor Christie of New Jersey not only preserve their room for political maneuver, but may also help themselves make a more reasoned decision when the choice is due.

While the scientific community continues to study the impacts of hydraulic fracturing, and to learn more about them, it seems at least unlikely that the environmental and health costs associated with reliance on natural gas approach the comparable costs of our reliance on coal. We cannot say this with certainty, but based upon what we know today, the costs of the latter dwarf those of the former. Furthermore, most of those who bear the health and other costs

associated with our reliance on coal are unrepresented in the shale gas policymaking process. Most of the people who die prematurely from exposure to airborne particles and other byproducts of coal combustion cannot identify their killer, and so never take part in debates over the relative merits of coal versus gas.[187] By contrast, most of those who bear the costs associated with shale gas production are aware of the costs that shale gas production will impose on them. Consequently, they are motivated to participate in that process, and to oppose fracking in their communities. Rational risk regulation, then, would suggest that politicians ought to be aware of the underrepresentation of coal's victims in the policy process.

None of which is to imply that states and local communities ought not to be able to make decisions regarding the regulation of fracking and shale gas production. To the contrary, as I have argued elsewhere,[188] they are best suited to make those decisions, because most of the impacts of fracking—both positive and negative—are felt locally. Nevertheless, policymakers ought not make those decisions myopically, but rather with a full understanding of all of the consequences (costs and opportunity costs) of each alternative. Indeed, one cannot make *responsible* decisions about shale gas production and fracking in any other way. It will take some doing, but it is up to decision-makers to rise above decision biases, or to help the public to do so. This process may take time, just as it has with climate change policy. Thomas Jefferson was philosophical about these kinds of delays and detours when he noted that "in every free [and] deliberating society there must, from the nature of man, be opposite parties [and] violent dissensions [and] discords," but that after "[a] little patience . . . . the reign of witches [shall] pass over,

187. Some adversely impacted by coal are aware of these costs, but tolerate them anyway. Support for the coal industry is high in the Appalachian states, which bear a good portion of the costs of exposure to airborne coal contaminants. *See* Epstein et al., *supra* note 124, at 84. This suggests an interesting environmental justice question: If those local opposition to shale gas production is greater than local opposition to coal production, is that due to socioeconomic disparities between coal and shale gas communities? If so, what environmental justice considerations does that raise for policymakers' consideration? Those questions are beyond the scope of this essay.

188. *See generally* David B. Spence, *Federalism, Regulatory Lags, and the Political Economy of Energy Production*, 161 U. PA. L. REV. 431 (2013).

their spells dissolve, and the people [will recover] their true sight . . . ."[189]

189. Letter from Thomas Jefferson to John Taylor (June 4, 1798), *available at* http://teachingamericanhistory.org/library/document/letter-to-john-taylor-2.