Case Western Reserve Law Review

Volume 63 | Issue 4 Article 11

2013

Climate Change and Natural Gas Dynamic Governance

Elizabeth Burleson

Recommended Citation

Elizabeth Burleson, *Climate Change and Natural Gas Dynamic Governance*, 63 Case W. Rsrv. L. Rev. 1217 (2013)
Available at: https://scholarlycommons.law.case.edu/caselrev/vol63/iss4/11

CLIMATE CHANGE AND NATURAL GAS DYNAMIC GOVERNANCE

Elizabeth Burleson†

"Every year, billions of dollars worth of natural gas are wasted; burned or flared at oil fields across the world. Such flaring produces some 400 million tons of greenhouse gas emissions."

—World Bank*

ABSTRACT

Hydraulic fracturing has been a game changer for the energy field, bringing to mind the "nothing in excess" carving at Delphi. Whether heeding ancient oracles or cutting-edge principles of calibration, I argue that dynamic governance innovation can facilitate climate-energy-water balancing to address natural gas governance gaps. Methane lost to the atmosphere not only disrupts the climate at a rate over twenty times that of carbon dioxide,[1] but it also constitutes a loss of revenue. Low natural gas prices and distance to markets have been the key drivers of flaring, absent a price on carbon dioxide, methane, and other climate destabilizers. Methane is the primary component—typically 70 to 90 percent—of natural gas.[2] Reducing methane emissions through governance innovation presents a profitable way of enhancing economic, social, and environmental synergies.

---

† Professor Elizabeth Burleson obtained her LL.M. from the London School of Economics and J.D. from the University of Connecticut School of Law and teaches energy law at Pace Law School and has served as an International Panel on Climate Change reviewer.

* *Global Gas Flaring Reduction Partnership*, WORLD BANK, http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0,,menuPK:578075~pagePK:64168427~piPK:64168435~theSitePK:578069,00.html (last updated Dec. 13, 2012) ("GGFR supports the efforts of oil producing countries and companies to increase the use of associated natural gas and thus reduce flaring and venting, which wastes valuable resources and damages the environment."); *see also* Massachusetts v. EPA, 549 U.S. 497, 532 (2007) (determining that states have standing to bring suit against the EPA to force it to regulate greenhouse gas pollutants).

1. EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2010, at ES-9 (2012); *see also Greenhouse Gas Equivalencies Calculator,* EPA, http://www.epa.gov/cleanenergy/energy-resources/calculator.html (last updated Mar. 13, 2013) (allowing for easy equivalency calculations between different types of greenhouse gases).

2. *See Background*, NATURALGAS.ORG, http://www.naturalgas.org/overview/background.asp (last visited Mar. 15, 2013).

Contents

Introduction

Venting and flaring natural gas flies in the face of efforts to address climate change.[3] Yet, the hydraulic fracturing debate remains characterized by an underlying sustainability tension among economic, social, and environmental integrity rather than a coordinated effort to find dynamic governance synergies. Rising natural gas leakage is a problem looking for a governance handle. The problem is becoming widespread, and existing regulation is inconsistent. Natural gas valued at $50 billion by the World Bank is flared annually, contributing around 400 million tons of CO_2 equivalent to climate change,[4] an amount equal to the

3. Dean Scott, *World Bank Sees Increase in Flared Gas Undermining Global Progress on Emissions*, Bloomberg BNA (July 6, 2012), http://news.bna.com/erln/ERLNWB/split_display.adp?fedfid=27270929&vname=ernotallissues&jd=a0d3k1v5e0&split=0 ("Russia remains the leading gas flaring nation, accounting for 37.4 bcm of flaring in 2011, followed by Nigeria (14.6 bcm); Iran (11.4 bcm); Iraq (9.4 bcm); and the United States (7.1 bcm), according to the data, culled from satellite data collected by the U.S. National Oceanic and Atmospheric Administration. . . . In 2011, the United States had the largest one-year increase of any country of 2.5 billion cubic meters from 2010 levels, a 54 percent increase. That was largely due to increased natural gas drilling in the United States, much of it from greater use of hydraulic fracturing or fracking."). A stable climate is a public good, the absence of which will thwart the provision of other public goods such as access to fresh water. The Intergovernmental Panel on Climate Change (IPCC) indicates that "[c]hanges in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation." Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report 50 (2007).

4. Roger Harrabin, *Gas Flaring Target of London Conference*, BBC News (Oct. 24, 2012), http://www.bbc.co.uk/news/science-environment-20055041 (highlighting a London flaring conference of the Global Gas Flaring Reduction partnership that has helped Russia cut flaring by 40 percent and Nigeria by 29 percent); *see also Key Achievements of GGFR Partners and the Way Forward*, Global Gas Flaring Reduction, http://www.flaringreductionforum.org/agenda.html (last visited Apr. 2, 2013) (providing conference schedule and access to presentations).

average annual energy consumption of Italy.[5] Innovative governance coordination can help reduce this waste by increasing the amount of gas sold to market, injected back underground, or used to power operations, and it can also increase local communities' access to energy.

Recontextualizing the fracking debate, this Article addresses unconventional natural gas from the underexplored contexts of energy systems analysis and social movement analysis. It seeks to highlight multi-problem-solving approaches that can transcend problem shifting to identify and implement broad energy-climate-water solutions. It does so through a public participation frame that can contribute to local, state, national, and global cooperation to expand energy availability and protect climate as a public commons.

Part I will provide an overview of the elements that make up the climate challenge to implement mitigation momentum. It will sketch the contours of the governance gap globally and in the United States, where oil and gas systems released nearly 40 percent of U.S. methane emissions.[6] While it may be challenging to monitor 1.5 million miles of natural gas pipelines throughout the United States, it is not only possible but also profitable to stop venting and flaring natural gas.[7]

Part II will suggest dynamic governance innovations that may be able to help diffuse natural gas political pressure. It will consider where federal coordination can interstitially work with local, state, and non-state-actor stakeholders. It will analyze how unconventional natural gas emissions of the potent greenhouse gas methane can be reduced through a combination of monitoring, technology-forcing measures that incentivize green technologies, and market-flexibility measures, such as cap and trade, which can help share aggregate information and

5. John Vidal, *World Bank Urges Nations to End 'Wasteful' Gas Flaring*, The Guardian (Oct. 24, 2012, 12:40 PM), http://www.guardian.co.uk/environment/2012/oct/24/world-bank-gas-flaring; *see also* Mark Clayton, *US Wastes More Natural Gas than Ever as Fracking Byproduct*, Alaska Dispatch (July 16, 2012), http://www.alaskadispatch.com/article/us-wastes-more-natural-gas-ever-fracking-byproduct ("About 5 trillion cubic feet of natural gas were flared or vented without burning worldwide last year. That huge amount of wasted energy is roughly equal to a quarter of all natural gas consumed in the US annually, the World Bank reports. Flaring also dumped 360 million tons of greenhouse gases into the atmosphere over the same period, equal to the exhaust of 70 million cars."). Russia, Nigeria, Iran, Iraq, and the United States release the highest greenhouse gas emissions via flaring. *Estimated Flared Volumes from Satellite Data, 2007–2011*, World Bank, http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0,,contentMDK:22137498~menuPK:3077311~pagePK:64168445~piPK:64168309~theSitePK:578069,00.html (last updated June 14, 2012).

6. EPA, Overview of Final Amendments to Air Regulations for the Oil and Natural Gas Industry: Fact Sheet, at 2 (2012), *available at* http://www.epa.gov/airquality/oilandgas/pdfs/20120417fs.pdf.

7. *Id.* at 3.

implement cost-effective green technologies that genuinely mitigate climate change. Part II will also offer recommendations for effective climate mitigation and enhanced energy access through innovation.

This Article concludes that inclusive decision making can help energy sites increase energy access and prioritize public health and environmental integrity as well as profit.

I base this Article upon the premise that social movement identities and objectives vary with context and access to information. Furthermore, I rest my topology on the premise that inclusive, dynamic decision making can reduce definitional uncertainty regarding what constitutes environmentally sound technology that expands energy access and addresses climate change.

Based upon the above premises, I map a topology of dynamic governance that can address the climate impacts of natural gas emissions through technical and public-private innovative coordination. In designing this theory, I rely on the following assumptions. First, I assume that flaring will continue in the context of expanding unconventional natural gas production.[8] Second, I assume that the private sector needs a social license to operate, irrespective of existing legal exemptions for unconventional natural gas extraction, and that there are many data points on a spectrum between social prohibition and full acceptance. In the middle realm of acquiescence, shared understandings can lead to economic, social, and environmental synergies. This cannot be genuinely accomplished through glossing over deeply held beliefs—be they economic, social, or environmental. Ecological and health thresholds are public goods on par with economic growth. Bonds that designate clean up funds to specified escrow accounts cannot redress the array of legal challenges facing cradle-to-grave unconventional gas development. Broader dynamic trans-boundary climate-energy-water cooperation can help fill key governance gaps. Low natural gas prices and distance to markets have been the key drivers of flaring, absent incentives to recognize the costs of greenhouse gas emissions and internalize these costs. Coordinating efforts to gather and share emissions information is a key element in recognizing the price of methane, carbon dioxide, and other greenhouse gases.

Dynamic governance can help increase methane leakage reporting in particular and greenhouse emission reductions generally. This Article argues that addressing energy and climate in an integrate manner should involve coordinated state and non-state initiatives to measure and reduce energy sector greenhouse gases. It does so with a particular emphasis on recent unconventional natural gas developments within the larger challenge to respond effectively to climate change.

8. *See* Interview by Spencer Mazyck, Bloomberg Law Legal Analyst, with author (June 21, 2011), *available at* http://www.youtube.com/watch?v=-UrDuU0UBRo (discussing risks and benefits of hydraulic fracturing).

I. Sketching the Contours of the Governance Gap

The United Nations Framework Convention on Climate Change (UNFCCC) has yet to be fleshed out into an implementation plan that can effectively address climate destabilization. With near-universal ratification of the framework climate convention, countries around the world committed to the precautionary principle of not letting uncertainty stand in the way of addressing climate change.[9] For the purposes of this Article, the following UNFCCC definitions will be foundational:

> 1. "Adverse effects of climate change" means changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare.
>
> 2. "Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.[10]

The task at hand is to overcome a complex collective action problem and start incentivizing environmentally sound innovation. Not everyone shares the same definition of environmentally sound technology or governance, yet finding shared understandings can help advance climate-energy-water coordination.

---

9. United Nations Framework Convention on Climate Change art. 3(3), May 9, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC] ("The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested Parties."). The convention entered into force on March 21, 1994, and today 195 countries are parties to the convention. *See also* Elizabeth Burleson, *Climate Change Consensus: Emerging International Law*, 34 Wm. & Mary Envtl. L. & Pol'y Rev. 543 (2010) (analyzing the growing international consensus on the need for adaptation to avoid catastrophic climate change).

10. UNFCCC, *supra* note 9, art. 1(1)–(2).

This brings us to the polarized hydrofracking debate. Hydraulic fracturing involves injecting millions of gallons of water, sand, and chemicals underground to fracture rocks, allowing oil and natural gas to flow back to the surface.[11] Combined with new horizontal drilling methods, hydraulic fracturing poses challenges to balancing economic, social, and environmental priorities.[12] This challenge is exacerbated by very low natural gas prices, due to warmer winters lowering demand and unconventional natural gas development causing a supply glut.[13] Cracked well casings and abandoned wells pose particular risks for reducing natural gas air and water emissions.[14] One particularly

11. *See* Hannah Wiseman, *Untested Waters: The Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation*, 20 FORDHAM ENVTL. L. REV. 115, 117–19 (2009) (describing the process in greater detail). Natural gas development impacts include: air emissions; reduced water availability and quality; industrial land use in close proximity to homes; and wastewater storage, treatment, and disposal challenges. Hydrofracking has come to mean different natural gas activities to different stakeholders. To natural gas operators, it refers to a very specific part of the natural gas production process, while the media have taken a wider interpretation encompassing the lifecycle of natural gas extraction.

12. *See* Mika Gröndahl, Bill Marsh & Graham Roberts, *Chemicals and Toxic Materials That Come With Hydrofracking: Waste Disposal and Other Hazards in Drilling for Natural Gas*, N.Y. TIMES (Mar. 1, 2011), http://www.nytimes.com/interactive/2011/03/01/us/chemicals-and-toxic-materials-in-hydrofracking.html (depicting unconventional natural gas development water risks); *see also* U.S. DEPT. OF ENERGY, SHALE GAS PRODUCTION SUBCOMMITTEE, SECOND NINETY DAY REPORT (2011) (discussing the Department of Energy's recommendations for improving the safety and reducing the impacts of fracking); REBECCA HAMMER & JEANNE VANBRIESEN, NRDC, IN FRACKING'S WAKE: NEW RULES ARE NEEDED TO PROTECT OUR HEALTH AND ENVIRONMENT FROM CONTAMINATED WASTEWATER (2012), (pushing for stronger safeguards against fracking contamination at the state and federal levels).

13. Dan Strumpf & Ryan Dezember, *Natural Gas Falls To Two-Year Low,* WALL ST. J., Dec. 31, 2011, at B1 (internal citations omitted) ("U.S. natural gas prices fell to their lowest point in more than two years, underscoring how the nation's booming energy business is becoming a victim of its own success. Prices for the commodity have been under pressure over the last couple of years, as new drilling techniques unlocked vast new stores of natural gas from shale formations and other so-called unconventional reservoirs. . . . [U]nusually mild temperatures across much of the U.S. have damped demand for gas to heat homes and offices. . . . 'The sub-$3 levels for gas prices in the winter really point to the incredible amount of nonconventional gas that has come onto the market the last two years,' . . . .").

14. *See* Joseph L. Sax, *Reserved Public Rights In Water*, 36 VT. L. REV. 535 (2012) (noting the underdevelopment of U.S. water law in regions outside the American West); A. Dan Tarlock, *Takings, Water Rights, and Climate Change*, 36 VT. L. REV. 731, 733–34 (2012) ("However imperative it may be to roll back greenhouse-gas emission levels,

problematic question is how to go about capping abandoned wells—a task complicated by underground fires and lack of records as to where mines were drilled.[15] Plugging abandoned mines is technically possible but expensive and hampered by this lack of records.[16]

The national debate over gas development in the United States is characterized by a dearth of information and lack of consensus over its environmental, economic, and social implications. Resources for the Future's "Pathways to Dialogue" work has involved survey-based statistical analysis of experts in government, industry, universities, and nongovernmental organizations to map risk pathways.[17] Finding shared understandings has been complicated by lack of information. Uncertainties impact the entire picture—geology, well types, horizontal drilling, fracturing fluids, fracture monitoring methods, watershed dynamics, airshed dynamics, socio-economic dynamics, research methods and funding, seismicity triggers, health thresholds, ecosystem service impacts, and public choice or public participation framing of the scope of public interest.

---

mitigation is largely an illusion in an era of constrained budgets, an increasingly dysfunctional American political system, the weakness of international environmental law, and the resistance of large segments of the energy industry to switching to a non-carbon-based future. The United States may try a few token gestures, such as carbon sequestration, and throw money at alternative energy research, but the status quo of continued reliance on hydrocarbon energy with the resulting greenhouse-gas emissions seems the norm for the foreseeable future."); *see also* Opinion, *The Facts About Fracking*, WALL ST. J., June 25, 2011, at A14 ("The Duke study did spotlight a long-known and more legitimate concern: the possibility of leaky well casings at the top of a drilling site, from which methane might migrate to water supplies. As the BP Gulf of Mexico spill attests, proper well construction and maintenance are major issues in any type of drilling, and they ought to be the focus of industry standards and attention.").

15. *See Pennsylvania's Burning Mines: Fire in the Hole*, ECONOMIST, Mar. 14, 2009, at 34 ("Evacuating people has proved cheaper than trying to put the fires out. The intricate subterranean network of tunnels and anthracite veins makes extinguishing them both expensive and uncertain to succeed . . . .").

16. Scientists are unsure of what to do about underground mine fires. *See id.* ("Red Ash is the oldest of 36 fires currently blazing in Pennsylvania's 180,000 acres (73,000 hectares) of abandoned mines. The most famous is beneath Centralia, which began in 1962 when residents burned some rubbish on top of an exposed coal seam. In 1981 a hole there swallowed an [sic] 12-year-old boy; Pennsylvania has since condemned the entire town, relocated almost all its residents and had its postal code revoked. Like Red Ash, Centralia's fire is thought to have enough fuel to burn for many more decades.)

17. 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 2–3 (2013).

The slow emergence of information into the public domain has focused the hydrofracking debate on the narrow frame of hydraulic fracturing fluid and wastewater,[18] to the exclusion of the equally important need to understand how to minimize methane's role in climate destabilization. Natural gas is largely methane (CH_4), presenting the challenge and benefit that the product is also the pollutant.[19] Capturing methane emissions provides a direct revenue stream and reduces a powerful greenhouse gas from exacerbating climate change. Natural gas is emerging as a strategic global commodity. Ice-class liquefied natural gas (LNG) tankers are now able to ship natural gas via ice-free summer Arctic Ocean routes to energy-compromised Japan. While countries such as France have banned hydraulic fracturing,[20] the U.S. unconventional natural gas boom has impacted the global gas marketplace, sending prices downward. Inexpensive gas is displacing coal in Canada and the United States. This displaced North American coal in turn is displacing costly Russian and Norwegian natural gas.[21]

18. *See, e.g.*, OFFICE OF RESEARCH & DEV., EPA, STUDY OF THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES: PROGRESS REPORT, at 1 (2012) ("In response to public concern, the US House of Representatives requested that the US Environmental Protection Agency (EPA) conduct scientific research to examine the relationship between hydraulic fracturing and drinking water resources. In 2011, the EPA began research under its *Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources.* The purpose of the study is to assess the potential impacts of hydraulic fracturing on drinking water resources, if any, and to identify the driving factors that may affect the severity and frequency of such impacts. Scientists are focusing primarily on hydraulic fracturing of shale formations to extract natural gas, with some study of other oil- and gas-producing formations, including tight sands, and coalbeds. The EPA has designed the scope of the research around five stages of the hydraulic fracturing water cycle." (citation omitted)); *see also About Us*, FRACFOCUS CHEMICAL DISPOSAL REGISTRY, http://fracfocus.org/welcome (last visited Mar. 15, 2013) (offering limited access to chemicals in hydraulic fracturing fluid by well).

19. *See* INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS, *supra* note 1, at ES-5 to ES-6.

20. *See* Stephen Gardner, *European Commission Opens Consultation on Hydraulic Fracturing in European Union*, BLOOMBERG BNA (Jan. 2, 2013), http://news.bna.com/ieln/IELNWB/split_display.adp?fedfid=28924407&vname=inernotallissues&jd=a0d5u9k1r9&split=0. Bulgaria and the Czech Republic have placed moratoriums on hydraulic fracturing as well, while Poland and the United Kingdom have permitted limited exploratory operations. *Id.*

21. *See* Eric Yep, *Gas Tanker Takes Shortcut to Asia*, WALL ST. J., Dec. 3, 2012, at C3 ("Lower European gas prices have implications for Russia's plan to sell gas via a pipeline to China. Russia has argued for a price based on European levels, something China has rejected.").

Given the increasingly global nature of natural gas development, dynamic governance networking can help identify and share best practices to minimize methane emissions. To this end, the World Bank Global Gas Flaring Reduction Partnership, launched at the 2002 World Summit on Sustainable Development, has helped (1) coordinate flaring reduction, (2) increase access to natural gas markets and (3) increase energy access through local, small-scale gas utilization.[22] From 2005 to 2010, this coordination helped reduce flaring of natural gas "by 22% from 172 billion cubic meters (bcm) to 134 bcm, according to satellite estimates . . . . The 13-bcm decline in 2010 is roughly equivalent to 30 million tons of CO_2 emissions, or to taking almost six million cars off the road."[23] Expanding energy access while minimizing wasted natural gas can help change the volatile dynamic of sabotaged pipelines into a shared understanding that the energy sector requires a social license to operate effectively.

II. Climate Governance Follow-through

Governance involves following through on commitments. Under the Vienna Convention on the Law of Treaties,

> A State is obliged to refrain from acts which would defeat the object and purpose of a treaty when: (a) it has signed the treaty or has exchanged instruments constituting the treaty subject to ratification, acceptance or approval, until it shall have made its intention clear not to become a party to the treaty . . . .[24]

Subsidizing fossil fuel to the exclusion of renewable energy and efficiency incentives arguably conflicts with the objective of the UNFCCC "to achieve . . . stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[25]

22. *About GGFR*, World Bank, http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0,,contentMDK:21022944~menuPK:828161~pagePK:64168445~piPK:64168309~theSitePK:578069,00.html (last visited Apr. 2, 2013).

23. GGFR, *Gas Flaring Down for Fifth Consecutive Year*, The News Flare, Mar.–Oct. 2011, at 1.

24. Vienna Convention on the Law of Treaties, art. 18, May 23, 1969, 1155 U.N.T.S 331; *see also id.* art. 31, ¶ 3 ("A treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms in their context and in light of its object and purpose."); Karl Zemanek, Vienna Convention on the Law of Treaties (2009) (summarizing the key provisions of the Vienna Convention and its subsequent impact on later developments).

25. UNFCCC, *supra* note 9, art. 2 ("The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant

UNFCCC commitments include reporting and mitigating greenhouse gas emissions.[26] Furthermore, the treaty binds countries to engage in inclusive and cooperative scientific, technological, and socio-economic innovation.[27]

Organisation for Economic Co-operation and Development (OECD) country fossil fuel subsidies ranged from $55 to $90 billion annually from 2005 to 2011—two-thirds of which went to petroleum

provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.").

26. *Id.* art. 4 ("(a) Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties; (b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change; (c) Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors; . . . (f) Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example impact assessments, formulated and determined nationally, with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change . . . .").

27. *Id.* ("(g) Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to the climate system and intended to further the understanding and to reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitude and timing of climate change and the economic and social consequences of various response strategies; (h) Promote and cooperate in the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change, and to the economic and social consequences of various response strategies; (i) Promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations . . . .").

and the remainder to coal and natural gas.[28] OECD fossil-fuel subsidy reform recommendations include: (1) increasing transparency of data, (2) engaging in targeted and transparent economic restructuring and poverty alleviation measures, (3) embedding fossil-fuel subsidy reforms within wider structural reforms, and (4) sustaining public trust that fossil-fuel subsidies are declining through open and inclusive communication and coordination among layers of government and non-state actors.[29]

The United States has substantially facilitated natural gas development, most recently committing roughly $29 million to optimize methane hydrate extraction from the Arctic.[30] Commercialization of frozen methane, which looks like ice but can burn like other fossil fuels, is constrained by difficulties in bringing such a remote resource to distant markets, yet it has benefited from U.S. Department of Energy and industry coordination—the kind of large-scale coordination needed for broad diffusion of renewable power. When the U.S. Energy Information Administration projects that renewables growth will only rise from 13 to 16 percent from 2011 to 2040, and many other entities embed these Energy Information

28. ORG. FOR ECON. CO-OPERATION & DEV., INVENTORY OF ESTIMATED BUDGETARY SUPPORT AND TAX EXPENDITURES FOR FOSSIL FUELS 2013, at 38 (2012); *see also* Rick Mitchell, *U.S. Lags on Using Energy Taxes to Achieve Environmental Goals, OECD Data Show*, BLOOMBERG BNA, (Feb. 13, 2013), http://news.bna.com/ieln/IELNWB/split_display.adp?fedfid=29590928&vname=inernotallissues&jd=a0d6g4y2u9&split=0 ("The United States generally does not use federal energy taxes as an environmental policy tool and ranks near the bottom of OECD's 34 member countries in terms of effective national energy tax rates on carbon dioxide emissions . . . . The highest overall effective carbon tax rates tend to be in European countries, where energy tax policy is significantly shaped by the 2003 EU Energy Taxation Directive (2003/96/EC), which set minimum tax rates for a variety of energy commodities . . . .").

29. Mitchell, *supra* note 28.

30. News Release, U.S. Dep't of Energy, Energy Department Advances Research on Methane Hydrates—The World's Largest Untapped Fossil Energy Resource (Aug. 31, 2012) ("[S]ignificant research remains to (1) analyze the role of gas hydrates in the natural environment (2) demonstrate that gas hydrates can be produced commercially in an environmentally responsible manner and, (3) further assess resource volumes, particularly in deepwater settings. These new projects, managed by the Energy Department's National Energy Technology Laboratory, will focus research on field programs for deepwater hydrate characterization, the response of methane hydrate systems to changing climates, and advances in the understanding of gas-hydrate-bearing deposits."); *see also* *U.S. Taps Supply of Frozen Methane*, L.A. TIMES, Nov. 23, 2012, at B3 (discussing a U.S. Department of Energy study of "methane hydrate, which looks like ice but burns like a candle if a match warms its molecules").

Administration projections in their own analyses, then path dependency may inhibit climate mitigation momentum.[31]

Global clean energy investment fell 11 percent in 2012 due to regulatory uncertainty, while U.S. clean energy investment crashed 32 percent due to uncertainty over energy incentives as well as competition from natural gas.[32] To my mind, climate-energy-water governance innovation requires sustained public support for renewable and efficiency measures that is at least as substantial as that for public-private fossil fuel collaboration.

Paradigm shifts require moving away from existing assumptions toward breakout solutions. Instead, we have fixated on natural gas as though it were a silver bullet solution. Frankly, if the comparison point is removing the tops of mountains, then most energy sources can trump coal on ecosystem integrity grounds.[33] To my mind, the

31. U.S. Energy Info. Admin., Annual Energy Outlook 2013: Early Release Overview 2 (2012) ("To provide a basis against which alternative cases and policies can be compared, the *AEO2013* Reference case generally assumes that current laws and regulations affecting the energy sector remain unchanged throughout the projection (including the implication that laws that include sunset dates do, in fact, end at the time of those sunset dates). This assumption helps increase the comparability of the Reference case with other analyses, clarifies the relationship of the Reference case to other *AEO2013* cases, and enables policy analysis with less uncertainty regarding unstated legal or regulatory assumptions."); *see also* Henry D. Jacoby, Francis M. O'Sullivan & Sergey Paltsev, *The Influence of Shale Gas on U.S. Energy and Environmental Policy*, 1 Econ. of Energy & Envtl. Pol'y 37, 38, 50 (2012) (finding that United States natural gas production may stunt the direction and intensity of renewable energy "by up to two decades" and will not "provide a 'bridge'" to a sound energy policy if it "erode[s] efforts to prepare a landing at the other end of the bridge").

32. Ari Natter, *Clean Energy Investment Falls 11 Percent In 2012, Bloomberg New Energy Finance Says*, Bloomberg BNA (Jan. 15, 2013), http://news.bna.com/deln/DELNWB/split_display.adp?fedfid=29091737&vname=dennotallissues&jd=a0d5z5b4f8&split=0.

33. International and national regulations are driving reduced coal use. *See* ClimateWire & Robert S. Eshelman, *Curbing Coal Mine Methane Could Cool Global Warming: Capturing or Burning the Methane Escaping from Coal Mines Around the World Would Help Slow Climate Change—and Improve Safety*, Sci. Am. (Sept. 7, 2012), http://www.scientificamerican.com/article.cfm?id=curbing-coal-mine-methane-could-cool-global-warming ("[W]hen those lumps of fuel are pulled from deep below the surface in northern China or exposed by a blast of dynamite on an Appalachian mountaintop, invisible plumes of methane gas seep out, as well."). The horizontal hydraulic fracturing revolution also involves coal bed methane. *See* Christopher Martin, *Coal Greens Love Buoyed by Shale Gas Hydraulic Fracking*, Bloomberg News (Aug. 29, 2012, 5:29 AM), http://www.bloomberg.com/news/2012-08-28/coal-greens-love-buoyed-by-shale-gas-hydrualic-fracking.html ("Development of coal gas is proceeding faster in places where natural gas is expensive and coal seams

metric should be shifted from coal to a comparison between natural gas and renewable energy. Further, cap and trade linking should involve methane mitigation options where feasible.

The Energy Information Administration recognizes that "different assumptions can affect projections of domestic production, prices, and consumption."[34] Similarly, Professor J.B. Ruhl explores the law and psychology dimensions of decision making under uncertainty.[35] Whether taking the Energy Information Administration's economic frame, Ruhl's psychological frame, or a hybrid sustainability frame, it remains difficult to retain a comprehensive focus. Ruhl identifies a valuable partial truth: the participation of self-perceived climate winners is integral to coordinated climate stabilization. Yet I argue that it is difficult to assess climate preferences where insufficient

are deep, including Canada, South Africa, New Zealand, China and Uzbekistan.").

34. U.S. Energy Info. Admin., *Projected Natural Gas Prices Depend on Shale Gas Resource Economics*, TODAY IN ENERGY (Aug. 27, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=7710 ("Considerable uncertainty exists regarding the size of the economically recoverable U.S. shale gas resource base and the cost of producing those resources. Across four shale gas resource scenarios from the Annual Energy Outlook 2012 (AEO2012), natural gas prices vary by about $4 per million British thermal units (MMBtu) in 2035, demonstrating the significant impact that shale gas resource uncertainty has in determining future natural gas prices. This uncertainty exists primarily because shale gas wells exhibit a wide variation in their initial production rate, rate of decline, and estimated ultimate recovery per well (or EUR, which is the expected cumulative production over the life of a well)."); *see also* News Release, U.S. Geological Survey, USGS Releases New Assessment of Gas Resources in the Marcellus Shale, Appalachian Basin (Aug. 23, 2011), *available at* http://www.usgs.gov/newsroom/article.asp?ID=2893&from=rss_home ("The Marcellus Shale contains about 84 trillion cubic feet of undiscovered, technically recoverable natural gas and 3.4 billion barrels of undiscovered, technically recoverable natural gas liquids according to a new assessment by the U. S. Geological Survey (USGS)."); Ian Urbina, *Geologists Sharply Cut Estimate of Shale Gas*, N.Y. TIMES, Aug. 25, 2011, at A16 ("This is drastically lower than the 410 trillion cubic feet that was published earlier this year by the federal Energy Information Administration."); News Release, U.S. Energy Info. Admin., Review of Emerging Resources: U.S. Shale Gas And Shale Oil Plays (July 8, 2011), *available at* http://www.eia.gov/analysis/studies/usshalegas (projecting available shale resources for plays across the U.S.).

35. *See* J.B. Ruhl, *A Summary of Present and Future Climate Adaptation Law*, *in* GLOBAL CLIMATE CHANGE AND U.S. LAW (Michael Gerrard & Jody Freeman eds., 2d ed. forthcoming 2013) (manuscript at 4–5), *available at* http://ssrn.com/abstract=2214001 ("[S]ome of the effects of climate change will present entirely new types of challenges for which there are no conventional models and methods of adaptation to adjust. . . . While these are not unimaginable events, it is not as if we have ready-made templates for now to manage them—they are the 'no-analog' phenomena of our climate change future.").

information has been made available. For instance, there are distinct notions of public health and individual health, but they are interrelated, and acting upon ongoing enhanced information can lead to greater health at both levels. The aggregate is often more than the sum of its parts when dealing with societies rather than numbers in isolation. A thousand people in a village or a university class are not equivalent to a randomly selected thousand people chosen from around the world. Social fabric is stronger than individual threads.

The question as to whether someone or some group of people would rather ride horses or drive cars depends on some familiarity with cars and horses. Knowing how one feels at sixty degrees versus eighty degrees does not mean that one can assess the complex feedback loops of climate-energy-water dynamics. It is unclear whether people would rather be thirsty or struggle with floods. Playing a mountainous island dweller who can withstand broader climate shocks is not, to my mind, climate winning so much as short-term or medium-term resilience. Increasingly, climate winners and losers will not be able to be isolated from one another. Perhaps this resilience is bought through self-interested isolation and a disregard for social ties and society safety nets. Perhaps it is sheer luck. As bullets are added to the barrel, however, climate roulette becomes more and more of a lose-lose proposition. Ruhl's key caveat is the notion of perceived winning, and here perception can be profoundly impacted by straightforward information. The core of my argument is that committing to coordinated networks of information gathering and shared solution generation can lead to breakout innovations, which may still allow net winners in this climate experiment in which we are all engaged, consciously or unconsciously.

Arctic energy is arguably a climate winner context for those in a position to extract natural gas, yet the uncertainty of methane releases across the Arctic renders such energy gambling a higher stakes game than one involving only individual or energy sector injury or fiscal loss.[36] With the horizontal hydraulic fracturing boom, the United States is glutted with natural gas and seeking export infrastructure, despite divergent public policies to expand renewable investment and commercialization. The national security reserves argument, which helped justify exempting hydraulic fracturing from federal environmental provisions to begin with, has not resurfaced as export options are explored. Leaving natural gas that can be horizontally hydraulically fractured in the ground rather than extracting it sounds less economically rational if energy conglomerates

36. *See* Elizabeth Burleson, *Polar Law and Good Governance*, *in* ROUTLEDGE HANDBOOK OF INTERNATIONAL ENVIRONMENTAL LAW, (Shawkat Alam et al. eds., 2012) (discussing the need for inclusive governance in the emerging legal area of commonly shared Artic natural-resource extraction).

like Shell estimate that Arctic undiscovered natural gas amounts to 30 percent of the global supply.[37] A perception of potential easy access to natural gas may dampen security concerns irrespective of which country has sovereignty over the largest natural gas reserves. Yet the International Law Commission has done important work on transboundary oil and gas resources and transboundary harm.[38] While methane emissions associated with gas releases arguably fall into both transboundary climate harm and a waste of transboundary oil and gas, significant governance gaps remain in incentivizing investments that can reduce loss of methane and help bring natural gas to market. Modern economies are dependent upon steady supplies of energy, yet public interests do not end with energy access. They extend to human rights, civil liberties, and environmental integrity. The energy sector has yet to implement best practices that could better balance economic, social, and ecosystem service synergies. For instance, Shell's ongoing failure to follow economic incentives or court orders to stop flaring is a direct violation of Nigerian law and economically irrational behavior.[39] It is an open question whether oil and gas development in the Arctic will be conducted any more responsibly. As a starting point, where oil and gas companies are flaring natural gas as a byproduct in pursuit of oil, this Article argues that greater coordination among natural gas developers and those protecting the public interest in health and ecosystem integrity can reduce flaring and bring natural gas to market.[40]

---

37. May Abdalla, *The Alaskans Sitting on Billions of Barrels of Oil*, BBC News (Nov. 29, 2012, 7:37 AM), http://www.bbc.co.uk/news/magazine-20310752#sa-ns_mchannel=rss&ns_source=PublicRSS20-sa.

38. *See, e.g.*, *Analytical Guide: Shared Natural Resources (Oil and Gas)*, Int'l L. Commission, http://untreaty.un.org/ilc/guide/8_6.htm (last updated May 16, 2012) (providing mandates, studies, and reports pertaining to oil and gas resources); *Texts & Instruments: Prevention of Transboundary Damage from Hazardous Activities*, Int'l L. Commission, http://untreaty.un.org/ilc/texts/9_7.htm (last updated Sep. 22, 2011) (providing draft articles with commentaries on prevention of transboundary harm from hazardous activities).

39. *See* Terry Macalister, *Tullow Oil Given Licence to Flare Ugandan Gas*, Guardian (Feb. 15, 2010), http://www.guardian.co.uk/business/2010/feb/16/tullow-oil-uganda-agreement ("The flaring of gas in Nigeria is regarded as the biggest source of CO_2 emissions in sub-Saharan Africa. Shell has repeatedly failed to follow through on premises to put an end to flaring, despite court orders demanding it stop.").

40. *See, e.g.*, *Kinder Morgan Absorbs Natural Gas Company for $5B*, EENews EnergyWire (Jan. 31, 2013), http://www.eenews.net/energywire/rss/2013/01/31/10 ("U.S. gas and oil pipeline giant Kinder Morgan Energy Partners is acquiring midstream natural gas company Copano Energy LLC for roughly $5 billion in a move that could help Kinder reduce natural gas flare-ups at its oil sites.").

The Energy Information Administration explains that

> [s]tarting in the mid-1970s, a partnership of private operators, the U.S. Department of Energy (DOE) and predecessor agencies, and the Gas Research Institute (GRI) endeavored to develop technologies for the commercial production of natural gas from . . . shale in the eastern United States. . . . [O]f the total 750 trillion cubic feet of technically recoverable shale gas resources[,] . . . the largest shale gas plays are the Marcellus (410.3 trillion cubic feet, 55 percent of the total), Haynesville (74.7 trillion cubic feet, 10 percent of the total), and Barnett (43.4 trillion cubic feet, 6 percent of the total).[41]

Since the oil and gas sector treats the Bakken Play as an oil rather than gas field, its significant natural gas resources are simply being wasted.[42] While over a third of the Bakken Play natural gas resource is being flared,[43] an international team of scientists has designed a catalyst that could break down methane. The bonds between the molecules in methane are hard to pull apart, requiring very high temperatures to sever. This catalyst, a university innovation benefiting from public investment, allows methane to be broken down at much lower temperatures by providing higher levels of oxygen for

41. U.S ENERGY INFO. ADMIN., REVIEW OF EMERGING RESOURCES: U.S. SHALE GAS AND SHALE OIL PLAYS 4 (2011) ("The use of horizontal drilling in conjunction with hydraulic fracturing has greatly expanded the ability of producers to profitably recover natural gas and oil from low-permeability geologic plays—particularly, shale plays. Application of fracturing techniques to stimulate oil and gas production began to grow rapidly in the 1950s, although experimentation dates back to the 19th century.").

42. *See id.* at 5 tbl.1 (listing the lower forty-eight states as having the following quantities of shale gas in trillion cubic feet as of January 1, 2009 (in descending order): Marcellus (410), Haynesville (75), Barnett (43), Fayetteville (32), Barnett-Woodford (32), Woodford (22), Eagle Ford (21), Mancos (21), Antrim (20), Devonian Low Thermal Maturity (14), Lewis (12), New Albany (11), Greater Sittstone (8), Big Sandy (7), Williston-Shallow Niobraran (7), Cana Woodford (6), Floyd-Neal & Conasauga (4), Hilliard-Baxter-Mancos (4), Cincinnati Arch (1), Avalon & Bone Springs (—), Bakken (—), Monterey/Santos (—)); *see also* U.S. Energy Info. Admin., *Geology and Technology Drive Estimates of Technically Recoverable Resources*, TODAY IN ENERGY (July 20, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=7190 (providing graphs for comparison of recoverable shale gas formations to conventional tight oil).

43. U.S. Energy Info. Admin., *Over One-Third of Natural Gas Produced in North Dakota is Flared or Otherwise Not Marketed*, TODAY IN ENERGY (Nov. 23, 2011), http://www.eia.gov/todayinenergy/detail.cfm?id=4030.

the reaction into water and carbon dioxide.[44] This kind of technological innovation, combined with such governance innovation as coordinating cap and trade and methane reduction linkages, can help address climate instability.

Despite much-needed breakthrough technologies, mitigating methane is also a straightforward task of implementing existing basic best practices. Perhaps the inability to see or smell methane has exacerbated the methane emission problem to date. If its status as a dangerous greenhouse gas is not appropriately recognized, then market failures and negative externalities are likely to continue. The following Section considers the governance capacity of the U.S. federal government in coordinating a genuine, timely shift from fossil fuels to renewables and efficiency.

A. United States Federal Coordination?

In 2012, President Obama issued an executive order entitled *Supporting Safe and Responsible Development of Unconventional Domestic Natural Gas Resources.*[45] Why not have similar individual initiatives for wind and solar? Is conflict the primary driver of policy? If so, solar spats with China and Atlantic wind-siting scuffles pale in comparison to stakeholder animosity over horizontal hydraulic fracturing. The information that is trickling into the public domain is meeting with divergent interpretations by disparate stakeholders. Much depends upon initial assumptions used to simplify models. One cannot assume away that lungs rely on clean air, but one can assume a robust, healthy, adult set of lungs rather than more susceptible youth, elderly, or asthmatic lungs.[46] Furthermore, while rural and urban lungs are indistinguishable absent pollution, greater concentrations of people in urban areas have led decision makers to prioritize a utilitarian, greatest-good-for-the-greatest-number approach

---

44. Tiffany Stecker, *New Catalyst Can Break Down Vehicle Methane Emissions*, EENEWS CLIMATEWIRE (Aug. 13, 2012), http://www.eenews.net/climatewire/rss/2012/08/13/6.

45. Exec. Order No. 13,605, 77 Fed. Reg. 23,107, (Apr. 13, 2012) (establishing an Interagency Working Group "in order to coordinate the efforts of Federal agencies responsible for overseeing the safe and responsible development of unconventional domestic natural gas resources and associated infrastructure and to help reduce our dependence on oil").

46. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, INFORMATION ON SHALE RESOURCES, DEVELOPMENT, AND ENVIRONMENTAL AND PUBLIC HEALTH RISKS 33 (2012) ("[P]articles from the sand, if not properly contained by dust control mechanisms, can lodge in the lungs and potentially cause silicosis."). The GAO produced a second report discussing additional health risks. U.S. GOV'T ACCOUNTABILITY OFFICE, UNCONVENTIONAL OIL AND GAS DEVELOPMENT: KEY ENVIRONMENTAL AND PUBLIC HEALTH REQUIREMENTS (2012).

to industry siting.[47] This Article argues that health and environmental co-benefits can help incentivize reducing methane emissions.

Offering a practically grounded, local land use solution, Professor John Nolon recommends that

> [l]ocalities interested in adopting effective and legally sustainable actions to control hydrofracking should add a component to their comprehensive plans regarding gas drilling, its impact on their communities, and the goals, objectives, strategies, and implementation measures they plan to adopt to control those impacts and to maximize the economic benefits of hydrofracking.[48]

To this end, the Environmental Protection Agency (EPA) can cooperatively facilitate local responses through model comprehensive plan language, while recognizing that substate governance may be the best scale for some aspects of unconventional natural gas oversight. Here, dynamic governance coordination can involve cooperative governance that can optimize gas oversight and energy innovation.

Maximizing energy access while minimizing environmental and social externalities may be a broad shared vision. For example, local fire departments might be best equipped to be first responders to emergencies at a well pad. Similarly, local police may have the greatest capacity to address the dangerous increase of industrial vehicle traffic on rural roads. At the other end of the spectrum, the EPA might be best positioned to set national chemical thresholds as it has done with diesel—setting it at zero for hydraulic fracturing operations.[49] Between these two remains a vast, ambiguous governance gap where overlaps and underlaps have left a dangerous level of uncertainty. Where federal response capacity is too slow, local implementation of federally designed best practices may best be carried out by those most familiar with local contexts, be they

47. *See, e.g.*, Vill. of Euclid v. Ambler Realty Co., 272 U.S. 365, 386–87 (1926) (establishing the constitutionality of single-use zoning under the state's police power).

48. John R. Nolon & Victoria Polidoro, *Hydrofracking: Disturbances Both Geological and Political: Who Decides?*, 44 Urb. Law. 507, 526–27 (2012); *see also* Julie V. Iovine, *Urban Development: Zoning Laws Grow Up*, Wall St. J., Jan. 19, 2012, at D6 ("Zoning has always concerned itself, for better or worse, with social matters, such as banishing noxious uses . . . . [P]lanning commission[s are] moving from zoning that's negative on social issues to being positive, like mandating green markets and bike rooms.").

49. *See* Hazardous Chemical Reporting: Community Right-to-Know, 40 C.F.R § 370.10 (2012) (setting hazardous chemical reporting thresholds for underground diesel storage tanks); *see also* 42 U.S.C. §§ 300f–300j (2006).

cultural or geological. Just as with climate mitigation and adaptation, preemption is an overly simplistic response to the need for new legal layers to address climate-energy-water challenges. States have been reeling from funding crises and it remains unclear how far drilling fees can spread to cover complex and expensive oversight of oil and gas system lifecycles. Federal pockets may be deeper, but actual resources to implement health and ecosystem service protection may be just as constrained. Drillers can be tasked with doing baseline tests prior to requesting permits, but this remains a small fraction of the oversight iterative process. That said, presuming industry contamination in the absence of baseline testing would incentivize testing rather than incentivize shoddy work. Doing so would be in the best interest of both drillers and landowners, by providing greater access to information with which to avoid conflicts.

Global greenhouse gas emissions are not solely of local concern. Yet, it is harder to reduce all levels of methane rather than just make sure methane leakage does not migrate into drinking water supplies. While no level of governance has had sufficient data with which to understand the scope of natural gas system emissions, governance coordination can still respond to the natural gas boom with methane emissions measures. It can be difficult for local governments to have oil and gas experts on staff, but if model instruments can be used as best practices, then maybe local capacity building can fill governance gaps more quickly than federal efforts, which do not always make it past the study stage to actual oversight implementation. Measures that can help increase data collection, while protecting health and ecosystem services, include permitting gas development with emissions limits as well as requiring baseline tests, fiscal bonds, and annual emissions reports from developers. It remains an open question whether states have the oversight capacity to match their rates of unconventional natural gas permitting. For instance, Pennsylvania granted 250 permits from December 2012 to January 2013.[50] It remains to be seen whether the state has the capacity to effectively regulate this scale of natural gas development. Even if well resourced, what do states have the ability to do *vis-à-vis* federal hydraulic fracturing exemptions? These legal quandaries remain perplexing to government officials and civil society alike.[51]

---

50. Emily Collins, Permitting Shale Gas Development: Considering Subsurface Migration in UIC & Shale Gas Permitting Decisions, Remarks at Florida State Law Spring 2013 Environmental Forum (Feb. 1, 2013), *available at* http://mediasite.apps.fsu.edu/Mediasite/Viewer/?peid=497fc6a51c50493a9a7529bb15d9f5ef1d (at 00:34:48).

51. *See* Tex. Water Code Ann. § 27.051(a)(1)–(3) (West 2012) ("The commission . . . may issue the permit if it finds: (1) that the use or installation of the injection well is in the public interest, . . . [and] (3) that, with proper safeguards, both ground and surface fresh water can be adequately protected from pollution . . . ."); Ohio Rev. Code Ann.

The EPA has a water study underway that may lead to reinstating federal regulations that were eliminated in the "Halliburton Loophole" of the Energy Act of 2005.[52] Those seeking to expand hydraulic fracturing generally favor state over federal regulation, which raises public choice and participation questions regarding rent seeking and protection of public interest. Notably, 40,000 public comments to the State of New York have broadened the deliberative process in the northern and most shallow section of the Marcellus Shale Play. On the national level, while Congress retains power to regulate unconventional natural gas development under the Commerce Clause of the U.S. Constitution, the federal government has generally left oil and gas regulation to the states. Few environmental or public health advocates at present have a comprehensive understanding of gas engineering and law, state-specific mineral leasing requirements, or intellectual and other property law dimensions.

Hydrofracking became economical by carving out responsibility for such negative externalities as pollution. Other factors include rising fossil fuel prices as well as technological advances in drilling horizontally using high-pressure hydraulic fracturing. The oil and gas industry successfully lobbied for exemptions for hydrofracking from several major federal environmental laws, many of which went into effect with the enactment of the Energy Policy Act of 2005.[53] In particular, industry lobbying succeeded in removing hydraulic fracturing from federal drinking water measures.[54] This has come to be known as the "Halliburton Loophole" to the Safe Drinking Water Act (SDWA).[55] Oil and gas drilling activities were also generally exempt from the Clean Air Act (CAA),[56] Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly

§ 6111.044 (West 2011) ("If the application demonstrates that the proposed activities will not comply or will pose an unreasonable risk of inducing seismic activity, inducing geologic fracturing, or contamination of an underground source of drinking water, the director shall deny the application.").

52. *See* Press Release, EPA, EPA Initiates Hydraulic Fracturing Study: Agency Seeks Input from Science Advisory Board (Mar. 18, 2010); Press Release, EPA, EPA's Science Advisory Board Announces Independent Panel to Peer Review Agency's Hydraulic Fracturing Research (Mar. 25, 2013).

53. *See* Energy Policy Act of 2005, Pub. L. No. 109-58, § 318, 119 Stat. 594, 693 (2005).

54. *See id.* § 322 (excluding certain elements of hydrofracking from SDWA).

55. *See* 42 U.S.C. § 300h(d)(1) (2006) (excluding "hydraulic fracturing operations" from the definition of "underground injection").

56. *See* 42 U.S.C. §§ 7401–7671 (regulating air quality and emission limitations).

known as "Superfund"),[57] and Resource Conservation and Recovery Act.[58] These statutes may still cover aspects of oil and gas processing.[59] Hannah Wiseman has discussed the manner in which Congress has exempted many hydraulic fracturing activities from federal provisions.[60] Fragmented federal provisions still address limited unconventional natural gas development under such statutes as the CWA, SDWA, NEPA, Endangered Species Act,[61] CAA, Emergency Planning and Community Right to Know Act (EPCRA),[62] and CERCLA.

Public choice theory considers rent seeking behavior. Stake holders do not always find common ground on what constitutes public interest as opposed to mere rent seeking. I argue that the rent seeking that resulted in carving a loophole out of the federal Safe Drinking Water Act and other public health and environmental provisions left a net loss to society. This net loss transferred wealth to extractive industries that no longer had to internalize the economic and social costs of operation when developing unconventional natural gas resources. Instead, the costs have been transferred to the international community that has already found it challenging to reduce methane and other greenhouse gasses, to communities that have had to respond to water contamination absent sufficient information with which to do so, and to individual residents drinking contaminated water and breathing high doses of life-shortening chemicals. This can be expressed in either complex medical, chemical, legal, and economic terms or in the most articulate, bravest way that impacted

57. *See* 42 U.S.C. §§ 9601–9675 (regulating hazardous substances releases, liability, and compensation).

58. *See* 42 U.S.C. §§ 6901–6992k (regulating solid waste disposal).

59. *Regulation of Oil and Gas Construction Activities*, EPA, http://cfpub.epa.gov/npdes/stormwater/oilgas.cfm (last updated Mar. 9, 2009).

60. *See* Wiseman, *supra* note 11, at 117 (noting that "Congress' exemption of fracing from the Safe Drinking Water Act involved two types of regulatory failure"); *see also* Hannah Wiseman, *Regulatory Adaptation in Fractured Appalachia,* 21 Vill. Envtl. L.J. 229, 250–51 n.125 (2010) (listing and explaining exceptions); Emily C. Powers, *Fracking and Federalism: Support for an Adaptive Approach that Avoids the Tragedy of the Regulatory Commons*, 19 J.L. & Pol'y 913, 938–39 (2011) (discussing the Energy Policy Act of 2005, 42 U.S.C. § 15801, and the exempting of hydraulic fracturing processes from the Safe Drinking Water Act, 42 U.S.C. §§ 300f–300j).

61. 16 U.S.C. §§ 1531–1544. For a discussion of the interaction of the Endangered Species Act and hydraulic fracturing, see Kaylani Robbins, *Awakening the Slumbering Giant: How Horizontal Drilling Technology Brought the Endangered Species Act to Bear on Hydraulic Fracturing*, 63 Case W. Res. L. Rev. 1143 (2013).

62. 42 U.S.C. §§ 11004–11049.

stakeholders know how during due process opportunities. Inclusive decision-making forums have been few and far between. Aggregating such insights can help reintegrate externalities into the cost of production.

In the vacuum of federal governance, jurisdictions and stakeholders have brought suits against one another to act or refrain from acting to regulate unconventional natural gas extraction.[63] Some legal handles to regulate flaring include implementing any remaining federal authority over unconventional natural gas extraction and enacting a variation of the proposed FRAC Act to reauthorize federal oversight of key unconventional natural gas development processes.[64] Given the current lack of momentum to pass the FRAC Act, what are the federal options to address this new problem of widespread natural gas flaring associated with horizontal hydraulic fracturing? How can the federal government optimize coordination with states through dynamic governance to fill existing governance gaps? For instance, when wells lack proper casing and cementing, stray gas can migrate from the wellbore.[65] In addition to this indirect leakage, gas developers vent and flair methane during normal operations and to reduce pressure in emergencies. The EPA's Mandatory Greenhouse Gas Reporting Program[66] encompasses methane and carbon dioxide emissions reporting for distributors and facilities emitting over 25,000 metric tons of greenhouse gases annually.[67] Yet, the EPA does not require greenhouse gas emission reductions through this program.[68]

63. *See generally Hydraulic Fracturing Case Chart*, ARNOLD & PORTER LLP, http://www.arnoldporter.com/resources/documents/Hydraulic%20Fracturing%20Case%20Chart.pdf (last updated Nov. 13, 2012) (providing a chart of the type of lawsuits brought and the names of the various cases).

64. Fracturing Responsibility and Awareness of Chemicals Act, S. 587, 112th Cong. (2011) (known as the FRAC Act).

65. "A Duke University study found drinking water methane concentrations to be seventeen times higher in active drilling and extraction areas than in non-active areas." Elizabeth Burleson, *Cooperative Federalism and Hydraulic Fracturing: A Human Right to a Clean Environment,* 22 CORNELL J.L. & PUB. POL'Y 289, 295 (2012) (citing Stephen G. Osborn et al., *Methane Contamination of Drinking Water Accompanying Gas—Well Drilling and Hydraulic Fracturing*, 108 PROC. NAT'L ACAD. SCI. 8172, 8173 (2011)).

66. *See generally* 40 C.F.R. § 98 (2011) (setting out the general provisions for the mandatory greenhouse gas reporting); *see also* 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).

67. 40 C.F.R. § 98.2 (2011).

68. *See id.* § 98.1 (requiring reporting of greenhouse gas emissions rather than reductions).

This program, combined with EPA's Tailoring Rule,[69] do not adequately incentivize greenhouse gas mitigation, which at some point should be recognized as a failure to abide by international obligations under the Framework Climate Convention commitments to report and implement iterative mitigation targets and programs.

On a positive note, the EPA Greenhouse Gas Reporting Program has increased access to information with which to make key energy-climate decisions. The natural gas sector had to report for the first time by January 16, 2013, detailing 2011 emissions. In 2011, roughly 8,000 facilities in nine industry sectors reported 3.3 billion tons of carbon dioxide equivalent (CO_2e), including direct emissions of carbon dioxide, methane, nitrous oxide, and fluorinated gases.[70] Notably, this reporting requirement did not encompass indirect emissions, which places it in a comparable position to the Clean Water Act's weak link on non-point source pollution. That said, it is worth having any data with which to assess natural gas emissions.

Pursuant to the Consolidated Appropriations Act of 2008, the EPA established the Greenhouse Gas Reporting Program requiring annual reporting of greenhouse gas data and other relevant information from large direct emissions sources and suppliers of certain fossil fuels and industrial gases in the United States.[71] This initiative to generate and share climate information could certainly be more robust, accurate and timely in order for public-private life cycle analysis, but it is an important step in the right direction toward understanding "emissions from specific industries, emissions from individual facilities, factors that influence greenhouse gas emission rates, and actions that facilities could take to reduce emissions."[72] Generally, a facility directly emitting 25,000 metric tons of carbon

69. *See* EPA, Final Rule: Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule (2010) (discussing how Clean Air Act permitting program requirements will apply to carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride beginning in 2011).

70. *GHGRP 2011: Reported Data*, EPA, http://www.epa.gov/ghgreporting/ghgdata/reported/index.html (last updated Feb. 5, 2013) ("Over 6,200 facilities across 29 source categories reported GHG data for [Reporting Year] 2010. In 2011, 12 additional source categories began monitoring GHG data and reported GHG data for the first time in 2012. The addition of these 12 new source categories brings the total coverage of the GHGRP to 41 source categories."). In contrast to just reporting emissions, and for a discussion of a stronger approach taken in the context of the FDA, see generally Barbara L. Atwell, *Products Liability and Preemption: A Judicial Framework*, 39 Buff. L. Rev. 181 (1991).

71. Consolidated Appropriations Act of 2008, Pub. L. No. 110-161, 121 Stat. 1844 (2007).

72. *Greenhouse Gas*, EPA, http://www.epa.gov/enviro/facts/ghg (last updated Feb. 4, 2013).

dioxide equivalent or more annually must report annual emissions to EPA. Furthermore, certain suppliers of products that could emit greenhouse gases also must report. Less than 5 percent of facilities emitted over 50 percent of 2011 emissions, suggesting that the federal regulation may be a good level at which to do the heavy lifting of incentivizing concentrated industry greenhouse gas emission reductions. Table 1 shows how the power plant, oil and gas, refinery, and chemical sectors produce the bulk of greenhouse gas emissions in that order.

Table 1: Top Sectors Required to Report Carbon Equivalence Emissions to EPA[73]

Industry Sector	Number of Reporters	Emissions (Million Metric Tons CO_2e)
Power Plants	1,594	2,221
Petroleum and Natural Gas Systems	1,880	225
Refineries	145	182
Chemicals	458	180

New EPA requirements to report oil, gas, and coal methane emissions reveal an 82.6-million-metric-ton methane contribution to climate destabilization that was, until 2013, off the public radar.[74] The EPA estimates that the new ruling will have the co-benefit of lowering methane by up to 1.7 million tons.[75] Based on my aggregation of the disparate data sets spread out across an interactive state-by-state EPA map, I calculated that in 2011 petroleum and natural gas systems reported emitting 7,392,982 million metric tons of CO_2e. The EPA database portal FLIGHT enables anyone with Internet access to view summary information, including facility maps, and to "easily search, sort, and download data."[76] While the scope of Confidential Business Information (CBI) and indirect emissions

73. *GHGRP 2011: Reported Data*, *supra* note 70.

74. Tiffany Stecker, *First-time Reports from Industry Reveal Massive Methane Emissions*, EENEWS CLIMATEWIRE (Feb. 6, 2013), http://www.eenews.net/public/climatewire/2013/02/06/2.

75. *Id.*

76. *GHGRP 2011: Reported Data*, *supra* at note 70; *see also id.* (mapping greenhouse gas emissions by sector using an interactive map of the United States); *2011 Greenhouse Gas Emissions from Large Facilities*, EPA, *available at* http://ghgdata.epa.gov/ghgp/main.do (last updated Jan. 15, 2013) (mapping greenhouse gas emissions by sector using an interactive map of the United States); *see also* EPA Greenhouse Gas Reporting Program, *Petroleum and Natural Gas Systems*, EPA, *available at* http://www.epa.gov/ghgreporting/ghgdata/reported/petroleum.html (last updated Feb. 14, 2013) (providing more environmental data).

warrants substantial further study, the initial stages of EPA efforts to shine light on the U.S. greenhouse gas footprint can help facilitate genuine climate mitigation. Whether this is done in a timely manner remains to be seen.

Notably, unconventional natural gas operations that are under 25,000 metric tons of carbon dioxide equivalent or more annually are not required to report—including a significant number of small, temporary but significant emitters extracting and releasing natural gas.

Indirect emissions through releases that are not directly emitted, but rather leaked, are also still invisible in the life cycle analysis data points available. Here, casing remains an issue, as do abandoned wells, if large-scale methane is reaching the atmosphere via fugitive leakage rather than directly flowing up the intended well.[77]

Table 2: Petroleum and Natural Gas Systems Sector—Greenhouse Gas Emissions Reported to EPA in million metric tons CO_2e[78]

Number of facilities:	1,880
Total emissions (CO_2e):	225
Emissions by greenhouse gas (CO_2e)	
• Carbon dioxide (CO_2):	142
• Methane (CH_4):	83
• Nitrous oxide (N_2O):	1

Natural gas development has risen by more than 20 percent over the past five years[79] due to a shale gas boom stimulated by horizontal drilling and hydraulic fracturing combined with a weakening of federal

77. Overview of Final Amendments to Air Regulations for the Oil and Natural Gas Industry, *supra* note 6, at 3–4 ("The oil and gas industry is a significant source of VOCs, which contribute to the formation of ground-level ozone (smog). Data provided to EPA's Natural Gas STAR Program show that some of the largest air emissions in the natural gas industry occur as natural gas wells that have been fractured are being prepared for production. During a stage of well completion known as 'flowback,' fracturing fluids, water, and reservoir gas come to the surface at a high velocity and volume. This mixture includes a high volume of VOCs and methane, along with air toxics such as benzene, ethylbenzene and n-hexane. The typical flowback process lasts from three to 10 days. Pollution also is emitted from other processes and equipment in the industry that prepare gas for sale and that assist in moving it through pipelines. . . . Many Gas STAR partners already are using the green completions that EPA is now requiring across the industry."); *see also Natural Gas STAR Program*, EPA, http://www.epa.gov/gasstar/index.html (last updated Feb. 22, 2013) (discussing Gas STAR partner's voluntary participation).

78. *Petroleum and Natural Gas Systems, supra* note 76.

79. Nicholas M. Bianco et al., World Res. Inst., Can the U.S. Get There from Here? Using Existing Federal Laws and State Action to Reduce Greenhouse Gas Emissions 49 (2013).

regulations on hydraulic fracturing. The EPA's evolving gas emissions inventory remains a moving target.[80]

The EPA recognizes that

> CH_4 emissions are not necessarily directly related to production. CH_4 emissions occur not just during mining, but also during the pre-mining stage and after mining is completed. In addition, the actual gas levels of a mine can vary significantly based on geologic factors. More accurate estimation would include information on the gas levels of mines in particular regions and mine operations in the pre-mining and post-mining stages.[81]

Yet the EPA has relied on pre-hydraulic-fracturing-boom data and explained that "[i]f emissions are not reported and [Energy Information Administration] production data are not available, EPA assumed zero emissions for this source."[82] The EPA admits that

> [c]urrent emissions calculations are based on quantity of oil and gas production and consumption. However, leakage and venting do not necessarily increase linearly with throughput, and newer equipment tends to leak less than older equipment. More accurate estimation methodologies would make use of counts of equipment and country-specific emission factors, but such information is not readily available for many countries. Even when more accurate methodologies are used, estimates for this source have significant uncertainty. . . . Abandoned mines are not considered in this analysis due to a lack of data.[83]

As a result, understanding the scope of climate destabilization due to unconventional natural gas production remains largely guesswork since insufficient monitoring and analysis have been undertaken to understand the scope of natural gas emissions.

This Article argues that EPA, state, local, and non-state actor cooperation can best achieve natural gas system rules that minimize methane as a greenhouse gas. The EPA set forth a timeline that until January 2015, natural gas system operators can flare or capture but

80. *See, e.g.*, Harvey et al., Leaking Profits 12 (2012) ("The largest change in methane emission estimates has been in accounting for wellhead and well pad processing facilities emissions that were substantially underestimated. . . . Revised emissions estimates range from 11 times higher for well venting from liquids unloading, to 36 times higher for gas well venting from conventional well completions, to 3,540 and 8,800 times higher for gas well venting during well workovers and completions of unconventional wells, respectively.").

81. EPA, Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2030 § 3.2.2 (2012).

82. *Id.* § 7.1.1.

83. *Id.* § 3.1.2.

should no longer be venting. Beyond January 2015, methane capture would be required of natural gas system operators who would no longer be allowed to conduct large scale flaring in the United States. As a result of litigation from both ends of the spectrum, the EPA is reconsidering both scope and timeframe.[84] In the meantime, some drillers are locked into contracts but generally operating at a loss given the low price of natural gas. With regard to the public interest, venting is a net welfare loss to society and flaring only marginally less so. Addressing these interrelated methane emission market and governance failures should be a priority for the EPA, Bureau of Land Management, states, tribes, substate governments, and non-state actors.

A dynamic governance response to the unconventional natural gas contribution to climate destabilization does not depend upon perfect natural gas life cycle understanding, just as the 2012 EPA rules on volatile organic compound and air toxics did not need to have perfect information. It is difficult to analyze a moving target given the rate of fuel switching from coal to natural gas underway in the electricity sector. That said, it is not impossible or even prohibitive. It is a key to making important energy-climate-water decisions going forward. The EPA is in a position to immediately incentivize natural gas reductions pursuant to the Clean Air Act.

84. Jessica Coomes, *Air Quality Standards: EPA to Re-Examine Fracking Air Rule, Wants Legal Challenges to Be Put on Hold*, 44 Env't Rep. (BNA) 201 (Jan. 25, 2013), *available at* http://news.bna.com/erln/ERLNWB/split_display.adp?fedfid=29304452&vname=ernotallissues&jd=a0d6b2y8t5 ("The Environmental Protection Agency told a federal appeals court it will reconsider aspects of air pollution standards for natural gas hydraulic fracturing operations and has laid out a schedule for further rulemaking (American Petroleum Institute v. EPA, D.C. Cir., No. 12-1405, motion filed 1/16/13). EPA asked the U.S. Court of Appeals for the District of Columbia Circuit on Jan. 16 to put the legal challenges on hold during the administrative reconsideration process. EPA did not specify which issues would be reconsidered. The agency also wants to separate the challenges into two cases. One case would focus on new source performance standards, and the other would address the challenge to national emissions standards for hazardous air pollutants. EPA's August 2012 final rule addressed both types of standards (77 Fed. Reg. 49,490). EPA asked the court to hold the new source performance standards issues in abeyance until Aug. 30 and the air toxics issues until May 30, 2014. EPA said it intends to reconsider some new source performance standards on an expedited schedule with a proposed rule by March 29 and a final rule by July 31. If necessary, other new source issues would be addressed in a proposed rule by Dec. 17 and a final rule by Nov. 25, 2014. A proposed rule on the air toxics reconsideration is expected by April 30, 2014, and a final rule by March 31, 2015."); *see also* Letter from Eric T. Schneiderman, N.Y. Attorney Gen., et al., to Lisa P. Jackson, Adm'r, EPA, (Dec. 11, 2012), *available at* http://www.ag.ny.gov/pdfs/ltr_NSPS_Methane_Notice.pdf (seven states, led by New York, served a formal notice of intent to sue the EPA under the Clean Air Act).

Pace Energy and Climate Center Director Franz Litz, in legal partnership with World Resources Institute, has mapped energy-climate ways forward. These include integrated federal-state coordination.[85] I argue that in addition to cooperative federalism, transboundary inclusive decision making can close the climate natural gas governance gap. Increased unconventional natural gas development can be expected to lead to more methane leakage.[86] Globally this presents both opportunities and challenges. It is hard to find lower lying fruit when trying to mitigate greenhouse gasses than the venting and flaring of natural gas. At the same time, governance coordination to mitigate natural gas emissions does require initial investment in establishing and supporting networks among international institutions, states, regional entities such as the EU, tribes, provinces, local governments, and non-state actors with expertise ranging from local insights to academic modeling expertise to industry experience. Through coordination programs such as the 2012 EPA regulations that reduce emissions of volatile organic compounds (VOCs), these entities can model best practices for minimizing fugitive methane emissions.[87] The EPA predicted that the

> combined rules will yield a cost savings of $11 to $19 million in 2015, because the value of natural gas and condensate that will

85. BIANCO ET AL., *supra* note 79, at 10 ("Given that it is unlikely that federal action will occur without state action or that state action will occur without federal action, we analyzed emissions scenarios with both federal and state action. States can be expected to continue to be active in areas of traditional state purview such as energy resource planning and energy efficiency, while also compensating for weak federal action. To capture this dynamic, we modeled varying levels of action for federal and state action.")

86. *See id.* at 12 ("Extraction of natural gas in the United States has increased by over 25 percent over the period of 2005 to 2011 due to rapid development of shale gas resources.").

87. *See* Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 77 Fed. Reg. 49,490, 49,490 (Aug. 16, 2012) (to be codified at 40 C.F.R. pts. 60 and 63) ("This action finalizes the review of new source performance standards for the listed oil and natural gas source category. In this action the EPA revised the new source performance standards for volatile organic compounds from leaking components at onshore natural gas processing plants and new source performance standards for sulfur dioxide emissions from natural gas processing plants."); *see also* 77 Fed. Reg. 56,422 (Sept. 12, 2012) (to be codified at 40 C.F.R. pts. 9 and 60) (amending new source performance standards for petroleum refinery process heaters and flaring systems); Standards of Performance for Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After May 14, 2007, 77 Fed. Reg. 56,425 (Sept. 12, 2012) (predicting net annual savings of $79 million given the value of gas captured).

> be recovered and sold will offset costs. . . . EPA's Regulatory Impact Analysis for the rule estimates the value of the climate co-benefits that would result from this reduction at $440 million annually by 2015. This includes the value of climate-related benefits such as avoided health impacts, crop damage and damage to coastal properties.[88]

The new source performance standards for the Crude Oil and Natural Gas Production source category regulate VOC emissions from gas wells, centrifugal compressors, reciprocating compressors, pneumatic controllers, storage vessels, and leaking components at onshore natural gas processing plants, as well as sulfur dioxide (SO_2) emissions from onshore natural gas processing plants.[89] The final rules review four petroleum and natural gas industry air regulations under the Clean Air Act: (1) a new source performance standard for VOCs, (2) a new source performance standard for sulfur dioxide, (3) an air toxics standard for major sources of oil and natural gas production, and (4) an air toxics standard for major sources of natural gas transmission and storage. The EPA explains:

> The Clean Air Act requires EPA to set new source performance standards . . . for industrial categories that cause, or significantly contribute to, air pollution that may endanger public health or welfare. EPA is required to review these standards every eight years. The existing [new source performance standards]—for VOCs and [sulfur dioxide]—were issued in 1985.[90]

88. OVERVIEW OF FINAL AMENDMENTS TO AIR REGULATIONS FOR THE OIL AND NATURAL GAS INDUSTRY, *supra* note 6, at 2–3.

89. *Id.* at 3 ("The VOCs and air toxics reductions in the rules are expected to improve outdoor air quality, protect against cancer risk from air toxics emissions and reduce health effects associated with exposure to ground-level ozone (smog). Exposure to ozone is linked to increased asthma attacks, hospital admissions and emergency room visits, and premature death. EPA was unable to model health benefit estimates for the rule, due to uncertainties about future locations of oil and gas emissions. Air quality changes associated with air toxics and VOC reductions can be highly localized.").

90. *Id.* at 4 ("In January 2009, WildEarth Guardians and the San Juan Citizens Alliance sued EPA, alleging that the Agency had failed to review the new source performance standards and the major source air toxic standards for the oil and natural gas industry. In February 2010, the U.S. District Court for the District of Columbia issued a consent decree that requires EPA to take actions related to the review of these standards. EPA issued the proposed rule July 28, 2011. The consent decree, which was recently revised, required that EPA take final action by April 17, 2012.").

While this takes a clear snapshot, it remains a snapshot that, like economic models, provides great clarity but finite scope. For instance, it remains murky what natural gas emissions occur in processes not covered by this rule (for example, either because data is not required for operations generating less than 25,000 metric tons of CO_2e or because natural gas emissions are a byproduct of another energy development process). Worrisome information gaps remain with regard to natural gas leakage from the Arctic generally as the climate destabilizes, aggregate emissions from hydropower as vegetation releases methane from the bottom of artificial lakes, or from fossil fuel production processes that accidentally or by design emit natural gas as a byproduct.[91]

The EPA explains that:

> For fractured and refractured gas wells, the rule generally requires owners/operators to use reduced emissions completions, also known as "RECs" or "green completions," to reduce VOC emissions from well completions. To achieve these VOC reductions, owners and/or operators may use RECs or completion combustion devices, such as flaring, until January 1, 2015; as of January 1, 2015, owners and/or operators must use RECs and a completion combustion device. The rule does not require RECs where their use is not feasible, as specified in the rule.[92]

While the timeframe of implementation is now a moving target, this is a prudent first step in genuinely minimizing natural gas emissions in the face of imminent or surpassed climate tipping points. After deliberation with industry and other stakeholders, the EPA balanced concerns by having the requirement commence in 2015 so that equipment supply chains can smoothly meet demand for green completion technology. Colorado, Montana, and Wyoming already

91. See, for example, Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 77 Fed. Reg. at 49,492, distinguishing between natural gas wells and oil wells: "The rule covers any gas well that is 'an onshore well drilled principally for production of natural gas.' Oil wells (wells drilled principally for the production of crude oil) are not subject to this rule."

92. *Id.*; *see also* Harvey et al., *supra* note 80, at 19 ("In a green completion, the operator brings temporary processing equipment to a well site during wellbore cleanup. Well cleanup fluids and gases are routed to the temporary processing equipment. Fluids, debris, and gas are separated, and gas and condensate are recovered for sale. The temporary processing equipment required for a green completion typically includes gas-liquid-sand separator traps, portable separators, portable gas dehydration units, additional tanks, and, sometimes, small compressors.").

require green completions, as does Fort Worth, Texas.[93] Once such state and local governance best practices are shared through governance networks, first instance technical expertise may be less important than general knowledge of industry best practices combined with incentives to advance technologies in ways that continue to be best practices in economic, social, and environmental contexts.

The natural gas boom has been an education in mining technology for many members of the general public concerned with health and environmental impacts. It helps to have cooperation among the drilling, health, and ecosystem services communities to identify and share optimal technical options including: "desiccant dehydrators to reduce emissions during dehydration of wet gas; improved compressor maintenance to reduce emissions during processing; hot taps in maintenance of pipelines during transmission; and vapor recovery units to reduce emissions during storage."[94] Responding to Oliver Houck's University of Oregon Human Rights and Environment Symposium challenge that singing Kumbaya is not enough,[95] it is important to emphasize that state and non-state coordination does not end with cooperative agreements as evidenced by the EPA/industry agreement that benzene would not be used in hydraulic fracturing. Non-binding agreements may sufficiently bind corporate responsibility and initiate innovative break out solution generation through shared insights. Yet they do not do all the heavy lifting.[96]

EPA's Natural Gas Star program has successfully gathered industry best practices and shared innovations to reduce methane emissions. This program recognized that methane emissions reduction is extremely important for health and environmental integrity, not to mention profitable, and significant headway has been made to bring best practices into broad commercial viability. Yet as NRDC notes, "Existing market forces, government regulations, and voluntary

---

93. Colo. Code Regs. § 404-1:805(b)(3) (2013); Mont. Admin. R. 17.8.1711 (2006); Fort Worth, Tex., Code of Ordinances art. 2, ch. 15, § 15-30 (2013); *see also* Harvey et al., *supra* note 80, at 21 (discussing the green completion equipment requirements in Colorado, Texas, Montana and Wyoming).

94. Bianco et al., *supra* note 79, at 50.

95. Oliver A. Houck, Professor, Tulane Univ. Law Sch., Keynote Address at the Journal of Environmental Law and Litigation Symposium: New Directions for Human Rights and the Environment (Sept. 29, 2012), *available at* http://www.youtube.com/watch?v=otmC5EpKXpg.

96. *See, e.g.*, Ellen M. Gilmer, *State Revokes Company's Permits After Wastewater Dumping,* EEnews EnergyWire (Feb. 8, 2013), http://www.eenews.net/energywire/rss/2013/02/08/7 ("Ohio regulators have permanently revoked the operating permits for two companies involved in dumping thousands of gallons of drilling wastewater into a Youngstown-area system that links to public drinking water.").

programs are only leading to the capture of a small percentage of methane emissions at present."[97] EPA's Natural Gas STAR Program estimates 50 percent of its oil and gas methane mitigation to green completions.[98] Only 20 percent of U.S. gas well emissions are captured through green completions so far.[99]

NRDC has identified the following technologies that can reduce over 80 percent of the petroleum and natural gas sector's methane emissions if used industry wide:

1. Green Completions to capture oil and gas well emissions
2. Plunger Lift Systems or other well deliquification methods to mitigate gas well emissions
3. Tri-Ethylene Glycol (TEG) Dehydrator Emission Controls to capture emissions from dehydrators
4. Desiccant Dehydrators to capture emissions from dehydrators
5. Dry Seal Systems to reduce emissions from centrifugal compressor seals
6. Improved Compressor Maintenance to reduce emissions from reciprocating compressors
7. Low-Bleed or No-Bleed Pneumatic Controllers used to reduce emissions from control devices
8. Pipeline Maintenance and Repair to reduce emissions from pipelines
9. Vapor Recovery Units used to reduce emissions from storage tanks

---

97. HARVEY ET AL., *supra* note 80, at 14; *see also id.* at 23 ("Plunger lift systems work by using the natural gas pressure that builds up in the casing tubing annulus to push a metal plunger up the well tubing, forcing a column of fluid to the surface. Gas and liquids are both collected. Liquids are separated from the gas, which is then routed to the pipeline for sale.").

98. *Id.* at 20; *see id.* at 15 ("[I]t is important to note that the EPA's Natural Gas STAR Program emission reduction estimates are based on data voluntarily submitted by industry. These data represent a very rough estimate of the amount of methane control that may have been achieved to date, because they were not developed using common and rigorous metering, measurement, quality control, or audit procedures. Therefore, some caution should be exercised in assuming that this amount of emissions reduction has been fully achieved."). *See generally Natural Gas STAR Program Accomplishments*, EPA, http://www.epa.gov/gasstar/accomplishments/index.html (last updated Apr. 18, 2013).

99. HARVEY ET AL., *supra* note 80, at 21.

10. Leak Monitoring and Repair to control fugitive emissions from valves, flanges, seals, connections and other equipment[100]

NRDC projects that green completions and plunger lift systems alone can reduce almost 40 percent of methane emissions.[101] Where gas pipelines are too far away, green completion capturing of natural gas can enhance the local affordable power supply, on site power generation, and well performance through reinjection.[102] While the trend is towards increasingly treating methane as a valued resource, the EPA will not require green completions for "[n]ew exploratory ('wildcat') wells or delineation wells (used to define the borders of a natural gas reservoir), because they are not near a pipeline to bring the gas to market" or for "[h]ydraulically fractured low-pressure wells, where natural gas cannot be routed to the gathering line. Operators may use a simple formula based on well depth and well pressure to determine whether a well is a low-pressure well."[103] The EPA estimates that 10 percent of hydraulically fractured wells are low pressure.[104]

100. *Id.* at 5. ("When development occurs on public lands, use of the technologies can result in royalty payments to the government from the sale of captured methane . . . . If better operating conditions and profits are not enough incentive to implement these projects, policies that mandate emissions control will be necessary to achieve the full potential of these methane control technologies.").

101. *Id.*; *see also* EPA, Lessons Learned from Natural Gas STAR Partners: Installing Plunger Lift Systems in Gas Wells 1, 4 (2006) ("Liquid loading of the wellbore is often a serious problem in aging production wells. Operators commonly use beam lift pumps or remedial techniques, such as venting or 'blowing down' the well to atmospheric pressure, to remove liquid buildup and restore well productivity. These techniques, however, result in gas losses. In the case of blowing down a well, the process must be repeated over time as fluids reaccumulate, resulting in additional methane emissions. . . . The most significant benefit of plunger lift installations is the resulting increase in gas production. During the decision process, the increase in production cannot be measured directly and must be estimated. The methodology for estimating this expected incremental production varies depending on the state of the well. The methodology for continuous or non-declining wells is relatively straightforward. In contrast, the methodology for estimating the incremental production for wells in decline is more complex.").

102. *See* Installing Plunger Lift Systems in Gas Wells, *supra* note 101, at 1 (discussing the benefits of plunger lift systems).

103. EPA, EPA's Air Rules for the Oil & Natural Gas Industry: Summary of Requrements [sic] for Processes and Equipment at Natural Gas Well Sites 2 (2012).

104. *See EPA to Phase in First Emissions Standards for Natural Gas Fracking Operations by 2015,* Bloomberg BNA, (Apr. 20, 2012), http://news.bna.com/erln/ERLNWB/split_display.adp?fedfid=25858729&vname=ernotallissues&jd=a0d1n8e4t0&split=0 ("The final rule also

It appears to be a chicken and egg problem to ask whether smaller hydraulic fracturing and related unconventional natural gas operations need to report given the lack of monitoring of fugitive natural gas to date. At the ends of the spectrum, very large and very small entities can safely estimate whether reporting is compulsory given the 25,000 metric tons of carbon dioxide equivalent threshold. It is not clear how many entities will underreport or fail to report due to a lack of information on actual natural gas emissions from their operations. While not a satisfying conclusion, an important first step in this context would be robust field analysis of actual greenhouse gas emissions to determine whether few, half, or most hydraulic fracturing operations fall into this reporting requirement. What is clear is that all operations beyond the United States do not have to report to the EPA, yet many such entities are beginning to model their natural gas initiatives on U.S. unconventional natural gas approaches. If this is done globally, absent reporting and mitigation requirements, then the natural gas sector will mushroom as a climate destabilization driver. At present, "[g]lobal warming pollution from natural gas systems accounts for approximately 4 percent of U.S. emissions."[105]

To my mind, incentivizing natural gas system methane reductions is one of the best ways to achieve near term climate mitigation. Under section 111 of the Clean Air Act[106] for new and existing natural gas systems, the EPA can incentivize the minimization of natural gas emissions by cooperatively implementing, monitoring, and enforcing methane and related pollutant (for example, VOC) emissions performance standards. The EPA made an important first stride with its 2012 petroleum and natural gas ruling. Just as regulating mercury[107] can have the ancillary benefit of reducing coal mine

exempts some new wells—including low-pressure wells, exploratory wells, and delineation wells—from the rule's requirements. EPA said it is technologically infeasible to use REC at low-pressure wells, which account for 10 percent of fracked wells.").

105. BIANCO ET AL., *supra* note 79, at 15.

106. For an overview of the Clean Air Act, see *The Plain English Guide to the Clean Air Act: Understanding the Clean Air Act*, EPA, http://www.epa.gov/airquality/peg_caa/understand.html (last updated Mar. 6, 2012).

107. For ongoing updates on EPA and Mercury, see *Mercury and Air Toxics Standards (MATS): Regulatory Actions*, EPA, http://www.epa.gov/mats/actions.html (last updated Mar. 28, 2013). *See also Laws and Regulations: Mercury Regulations and Standards*, EPA, http://epa.gov/hg/regs.htm (last updated Mar. 29, 2013) ("In December 2011, EPA issued the first national standards for mercury pollution from power plants. MATS are the first national standards to protect American families from power plant emissions of mercury and toxic air pollution like arsenic, acid gas, nickel, selenium, and cyanide. The standards will slash emissions of these dangerous pollutants by relying on widely available,

methane emissions that amounted roughly to 1 percent of U.S. greenhouse gas emissions in 2010,[108] regulating VOCs can reduce natural gas emission impacts on climate change. The impact on human health from VOCs is more directly understood and attributable to natural gas systems. This perhaps explains why the EPA has sought to enact volatile organic compound rules for natural gas systems and has yet to directly regulate methane as a greenhouse gas.[109] The EPA could also address coal mine natural gas emissions directly under section 111 of the Clean Air Act.

In conjunction with federal incentives, state energy-climate-water laboratories can model different approaches to coordination to reduce greenhouse gases through energy innovations. State collaborative models include the Regional Greenhouse Gas Initiative (RGGI),[110] while the California Assembly Bill 32[111] and individual state renewable portfolio standards that twenty-nine states have established can be looked to as a threshold below which federal momentum on renewables and efficiency should not descend.[112] It remains an open

proven pollution controls that are already in use at more than half of the nation's coal-fired power plants."); National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units, 77 Fed. Reg. 9304 (Feb. 16, 2012) (to be codified at 40 C.F.R. pts. 60 and 63).

108. Bianco et al., *supra* note 79, at 19.

109. *See Volatile Organic Compounds (VOCs) in Commonly Used Products*, N.Y. Dep't of Health, http://www.health.ny.gov/environmental/indoors/voc.htm (last updated Oct. 2012) ("Short-term exposure to high levels of some VOCs can cause headaches, dizziness, light-headedness, drowsiness, nausea, and eye and respiratory irritation. These effects usually go away after the exposure stops. In laboratory animals, longterm exposure to high levels of some VOCs has caused cancer and affected the liver, kidney and nervous system.").

110. *See Program Design*, Reg'l Greenhouse Gas Initiative, http://www.rggi.org/design (last visited Apr. 3, 2013) (describing the RGGI as a multi-state cooperative aiming to reduce carbon dioxide emissions through the use of Budget Trading Programs).

111. Signed into law on September 27, 2006, as the Global Warming Solutions Act of 2006, Cal. Health & Safety Code §§ 38500–38599 (2006).

112. *See, e.g.*, *State-Federal RPS Collaborative*, Clean Energy States Alliance, http://www.cleanenergystates.org/projects/state-federal-rps-collaborative (last visited Apr. 3, 2013) ("Renewable portfolio standards are an important tool that 29 states have established to encourage clean energy investment in the U.S."); U.S. Energy Info. Admin., *A Clean Energy Standard Could Reduce Power Sector Carbon Dioxide Emissions*, Today in Energy (May 4, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=6130 (discussing reductions of carbon dioxide emissions under clean energy standards).

question as to what degree the hydraulic fracturing revolution has impeded state-federal cooperative federalism capacity to meet and implement renewable portfolio standards. We need more than rhetoric to facilitate a transition to renewables and greater efficiency. Federal power is powerful in the energy context.[113] Federalism comes in many shapes and sizes (for example, national speed limits and federal lights-out decrees).[114] Similarly, states and substate governments can utilize

113. For the importance of federal power, see THE FEDERALIST NO. 45 (James Madison) (discussing the importance of the public good); Robin Kundis Craig, *Constitutional Contours for the Design and Implementation of Multistate Renewable Energy Programs and Projects*, 81 U. COLO. L. REV. 771, 780–81 (2010) (discussing Congress's authority over energy and the Commerce Clause); Oliver A. Houck & Michael Rolland, *Federalism in Wetlands Regulation: A Consideration of Delegation of Clean Water Act Section 404 and Related Programs to the States*, 54 MD. L. REV. 1242, 1244 (1995) (discussing a strong federal role in the contest of wetlands while recognizing the importance of active state partnership). For other environmental federalism perspectives, see Robert V. Percival, *Environmental Federalism: Historical Roots and Contemporary Models*, 54 MD. L. REV. 1141, 1171–72 (1995) (discussing models of environmental federalism and the factors that have contributed to the federalization of environmental regulation). *See also* Ann E. Carlson, *Iterative Federalism and Climate Change*, 103 NW. U. L. REV. 1097, 1139–41 (2009) (discussing how environmental iterative federalism can optimize collective decision-making); Kirsten H. Engel, *Harnessing the Benefits of Dynamic Federalism in Environmental Law*, 56 EMORY L.J. 159, 175–77 (2006) (considering the dimensions of dynamic environmental federalism); Robert L. Glicksman & Richard E. Levy, *A Collective Action Perspective on Ceiling Preemption by Federal Environmental Regulation: The Case of Global Climate Change*, 102 NW. U. L. REV. 579, 593–602 (2008) (considering collective action in the context of climate coordination); Patricia E. Salkin & Ashira Pelman Ostrow, *Cooperative Federalism and Wind: A New Framework for Achieving Sustainability*, 37 HOFSTRA L. REV. 1049, 1051–52 (2009) (discussing federal limits to state siting restrictions on wind power); Benjamin K. Sovacool, *The Best of Both Worlds: Environmental Federalism and the Need for Federal Action on Renewable Energy and Climate Change*, 27 STAN. ENVTL. L.J. 397 (2008) (proposing a model of interactive federalism including national floors and climate change quotas); Amy L. Stein, *The Tipping Point of Federalism*, 45 CONN. L. REV. 217, 231 n.52 (2012) ("One argument is that 'the federal government is well-equipped to provide capital-intensive services like the construction of deep salt-lined storage facilities for high-level nuclear waste, but is likely to be inept at conducting labor-intensive services like the management of public hearings to minimize public opposition to waste sites.'" (quoting Roderick M. Hills, Jr., *The Political Economy of Cooperative Federalism: Why State Autonomy Makes Sense and 'Dual Sovereignty' Doesn't*, 96 MICH. L. REV. 813, 869–79 (1998))).

114. *See* Stein, *supra* note 113, at 222 n.14 ("In response to the 1973 Oil Embargo, Congress passed the 1974 Emergency Highway Energy Conservation Act that established a national speed limit only to repeal the law over twenty years later to tip power back to the states."); *see also France: Countrywide 'Lights Out' Measure Aims to Save Energy*, EENEWS GREENWIRE (Feb. 1, 2013), http://www.eenews.net/Greenwire

the state police powers to strengthen state and local building codes mindful of climate-energy-water synergies. Within the realm of health, safety, morals, and general welfare lies a realm of state governance capacity that can fold into federal and non-state actor initiatives. Utilizing this capacity can perhaps allow us to forgo lengthy and resource-consuming efforts to hash out federal and individual rights that often overlap with state and substate interests in protecting health, safety, morals, and general welfare.

Efficiency improvements in residential, commercial, and industrial systems provide greenhouse gas benefits by reducing demand for fossil fuels. States have already begun implementing efficiency measures that reduce demand for natural gas by decreasing the need to heat.[115] State and local governments in the United States have traditionally incentivized building improvements through such instruments as building codes,[116] and this may be the best way of reducing the 7 percent of U.S. emissions attributable to commercial and residential heating—largely natural gas combustion for heating, cooking, and water heating.[117]

Unlike many energy efficiency measures, combined heat and power (CHP) can increase energy diversity and security through cogeneration, but by its very nature it presents trade-offs as distributed power generation in close proximity to customers brings waste byproducts as well as beneficial waste heat.[118] States can help

/2013/02/01/26 ("Commercial buildings in France will have to turn off their lights as part of a government decree issued this week. The measure requires the interior lights of shops and offices to be turned off an hour after the last worker leaves. Lights on storefronts and shop windows must be shut off by 1 a.m. The Eiffel Tower and other major attractions will be allowed to keep lights turned on during the night. Delphine Batho, France's environment minister, said the country aims to be a 'pioneer' in reducing light pollution. In a statement, she said the law, part of a larger initiative to increase energy efficiency and cut back on waste, would also reduce carbon dioxide emissions by 250,000 tons a year. Batho also said the measure would improve public health, adding that artificial lighting can affect sleep patterns and the ecosystem.").

115. *See* Bianco et al., *supra* note 79, at 78–83.

116. *Id.* at 81–83.

117. *Id.* at 19.

118. *See* U.S. Energy Info. Admin*, Combined Heat and Power Technology Fills an Important Energy Niche*, Today in Energy (Oct. 4, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=8250 ("CHP systems operate with a wide range of fuels. Natural gas, however, is the most common primary energy source used in combined heat and power stations, followed by coal and biomass (often in the form of waste products at paper mills). Over 65% of CHP capacity currently operating in the United States is using natural gas as a primary fuel source . . . ."); *see also* Saqib Rahim, *Billions Needed to Immunize Oil and Gas tech from Attacks—Report*, EENews EnergyWire (Jan. 30, 2013), http://www.eenews.net/energywire/rss/2013/01/30/3 ("Modern

balance incentives for microgrids and distribute power through such instruments as net metering,[119] while also implementing output-based air pollution regulations.[120] Generally, natural gas mitigation technologies can pay for themselves within several years without a price on carbon because capturing natural gas generally increases the amount of natural gas available for sale.[121] This is not necessarily the case in North Dakota where infrastructure is sparse and transporting natural gas remains expensive.

The following chart shows the first reported natural gas systems emissions from highest-emitting state to lowest-emitting state.[122] Looking at the fourth column, a comparison can be made among states with high natural gas system emissions and renewable portfolio standards.[123]

---

computing has made that infrastructure ever more sophisticated, with sensors and controls increasingly tied into the company's internal network. It makes for a leaner operation, but it's opened up new doors for cybercriminals.").

119. *See New York: Incentives/Policies for Renewables and Efficiency*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY05R (last updated Nov. 12, 2012) (explaining the net-metering incentive for New York); *Net Energy Metering (NEM)*, CALIFORNIA PUB. UTIL. COMMISSION, http://www.cpuc.ca.gov/PUC/energy/DistGen/netmetering.htm (last updated Jan. 9, 2013) ("Customers who install small solar, wind, biogas, and fuel cell generation facilities (1 MW or less) to serve all or a portion of onsite electricity needs are eligible for the state's net metering program. NEM allows a customer-generator to receive a financial credit for power generated by their onsite system and fed back to the utility. The credit is used to offset the customer's electricity bill.").

120. BIANCO ET AL., *supra* note 79, at 84.

121. *Id.* at 50 ("Our middle-of-the-road scenario assumes that EPA implements regulations that require natural gas systems to employ the above emissions control technologies—as well as conversion of existing highbleed pneumatic controllers to low-bleed or no-bleed controllers—to reduce emissions from processing and transmission. This technology is predicted to have a payback period of less than two years with a $20 price on carbon, and is projected to pay for itself within three years even without a price on carbon. . . . Our go-getter scenario assumes that EPA implements regulations that require natural gas systems to employ all of the emission control technologies identified in the lackluster and middle-of-the-road scenarios, as well as: 1. Hot taps to reduce emissions from pipeline maintenance and repair during transmission; 2. Desiccant dehydrators to reduce emissions during dehydration of wet gas; 3. Improved compressor maintenance to reduce emissions during processing; and 4. Vapor recovery units to reduce emissions during storage.").

122. *2011 Greenhouse Gas Emissions from Large Facilities*, *supra* note 76.

123. *Renewable Portfolio Standard Policies*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (Mar. 2013), http://www.dsireusa.org/documents/summarymaps/RPS_map.pdf.

Table 3: States with the Highest Petroleum and Natural Gas Emissions, 2011[124]

State	Emissions (million tons CO_2e)	Sites[125]	Mandatory RPS or non-binding Renewable Portfolio Goal
Texas	23	285	5,880 MW by 2015
Louisiana	16	204	
Alaska	12	28	
Wyoming	11	77	
California	10	62	20% (33%) by 2010 (2020)
New Mexico	6.8	47	20% by 2020
Illinois	6.0	30	25% by 2025
Colorado	5.8	71	30% by 2020
Oklahoma	3.7	68	15% by 2015 (goal)
Pennsylvania	3.1	49	18% by 2021
Alabama	2.6	29	
Arkansas	2.4	58	
Michigan	2.1	24	10% by 2015
Kansas	2.0	36	20% by 2020
Mississippi	1.9	34	
New York	1.9	19	29% by 2015
Indiana	1.8	23	10% by 2025 (goal)
North Dakota	1.5	22	10% by 2015 (goal)
Ohio	1.3	17	12.50% by 2025
West Virginia	1.2	20	25% by 2025 (goal)
Utah	1.1	21	20% by 2025 (goal)
New Jersey	1.0	8	20.38% by 2021
Washington	0.96	9	15% by 2020
Florida	0.84	15	
Georgia	0.76	8	
Iowa	0.73	19	105 MW
Minnesota	0.73	12	25% by 2025
South Dakota	0.73	1	10% by 2015 (goal)

124. Based on the charts from *2011 Greenhouse Gas Emissions from Large Facilities*, *supra* note 76; *Renewable Portfolio Standard Policies, supra* note 123.

125. "Sites" are the number of facilities in the petroleum and natural gas industry that emit over 25,000 metric tons of greenhouse gases per year and are therefore required to report emissions to the EPA.

Missouri	0.72	9	15% by 2021
Virginia	0.72	11	15% by 2025 (goal)
Kentucky	0.68	15	
Massachusetts	0.65	7	15% by 2020
Tennessee	0.64	12	
Arizona	0.55	16	15% by 2025
Maryland	0.54	6	20% by 2022
North Carolina	0.53	8	12.50% by 2021
Nebraska	0.39	6	
Connecticut	0.35	7	27% by 2020
Oregon	0.29	6	25% by 2025
Nevada	0.29	5	25% by 2025
Idaho	0.27	9	
Montana	0.27	10	15% by 2015
New Hampshire	0.23	1	24.80% by 2025
South Carolina	0.21	3	
Rhode Island	0.18	2	16% by 2020
Wisconsin	0.13	5	10% by 2015
Delaware	0.034	2	25% by 2026
Hawaii	0.032	2	40% by 2030
Maine	0.031	2	10%[126] by 2017[127]
Vermont	0.0	0	20% by 2017
District of Columbia	0.0	0	20% by 2020

It is important to emphasize that the above reported numbers do not account for methane emissions from soil. To date, the scientific literature has focused on wellhead leaks, but methane emissions from the ground also significantly contribute to climate change.[128] While geological variations may impact the leakage of methane from soil, ignoring this category renders a comparison between natural gas and coal, or any other fuel, premature and inaccurate. Australian researcher Isaac Santos explains that infrastructure leakage is a more

126. New renewable resources; existing RPS is 30% and has been since 2000.

127. Increasing 1% every year for ten years, until reaching 10% by 2017.

128. Michael Slezak, *Methane Leaks Suggest Fracking Benefits Exaggerated*, New Scientist (Nov. 21, 2012), *available at* http://www.newscientist.com/article/dn22521-methane-leaks-suggest-fracking-benefits-exaggerated.html (noting that Damien Maher found higher levels of methane in the air above the Australian Tara gas field).

straightforward fix than methane seeping from the soil.[129] Unfortunately, easy metrics are not the objective. Cradle-to-grave natural gas system reporting, including soil, may require multi-variant analyses, but can be recognized as part of the iterative obligation under the UNFCCC to report and implement climate mitigation. At the federal level in the United States, the EPA should not only require direct natural gas emissions reports from entities over the 25,000 metric ton CO_2e threshold, but also coordinate aggregate accurate information generation of life cycle natural gas system methane emissions with other federal entities such as the Bureau of Land Management. Together, these federal pieces in the larger energy-climate-water coordination challenge can work with tribes, states, counties, cities, towns, and other jurisdictions in cooperative ways to put in place best practices. To my mind, identifying and implementing these best practices can best be achieved through innovative governance with relevant non-state actors—not only those with drilling expertise, but those with health and ecosystem expertise.

Methane mitigation insight generation and oversight challenges can vary substantially by context. To give but one example, the capacity of plunger lifts to reduce methane emissions by 40 percent may not have been public knowledge, but through coordination among natural gas developers and environmental nongovernmental organizations, it is becoming a better known best practice. Cooperative EPA, state, and local requirements to implement plunger lift technology directly would exemplify innovative governance in the methane mitigation context. Since future technologies may displace plunger lift technology as a best practice, adaptive governance should work with state and non-state expertise (industry, social, and environmental) to incentivize evolving best practices.

A broader accounting of natural gas emissions should also include responsibility to fix leaking pipelines. A joint Boston University and Duke University study mapped significant natural gas emissions from worn out pipeline infrastructure under Boston. This study concludes that "[r]epairing leaky natural gas distribution systems will reduce greenhouse gas emissions, increase consumer health and safety, and save money."[130] Boston is not the only jurisdiction contending with

129. *Id.*

130. Nathan G. Phillips et al., *Mapping Urban Pipeline Leaks: Methane Leaks Across Boston*, 173 Envtl. Pollution 1 (2013), *available at* http://www.sciencedirect.com/science/article/pii/S0269749112004800. The study mapped methane leaks across the entire 785 road miles in the city of Boston, identifying 3,356 methane leaks with concentrations exceeding up to 15 times the global background level and methane isotopic signatures that strongly indicate a fossil fuel source rather than a biogenic source (e.g., wetlands). *Id. See also* Anne C. Mulkern, *Numerous Problems put Pipelines at Risk for Break, Explosion–Report,* EEnews Greenwire (Mar. 15, 2012), http://www.eenews.net/Green

methane emissions via leaking natural gas pipelines.[131] I derived Table 3 from an interactive EPA website that was designed to provide local air quality information since volatile organic compounds are a smog precursor. The EPA now has metrics with which to assess where leaky pipes and other old residential heating infrastructure play a larger role than unconventional natural gas extraction.

It is important to determine whether emissions are attributed to the states where natural gas is extracted or to the states where the natural gas is used by customers to heat homes or run electrical appliances. The EPA may be best positioned to incentivize reporting and implementation of methane capture from leaky pipelines—which have the same effect as venting natural gas directly from wellheads.

The EPA may also be able to coordinate with states and substate counterparts to incentivize natural gas intermediate and end use methane mitigation. Here, folding methane into RGGI efficiency and methane reduction approaches that then link to other cap and trade systems may be able to reduce methane emissions through aggregate market processes in a more effective manner than government efforts to aggregate such diffuse information at the residential level across whole regions. That being said, local land use decision makers that contribute sustainable building code updates could substantially drive down methane emissions through efficiency and better building materials and methodologies. In other words, life cycle natural gas mitigation may be most effectively achieved by linking natural gas systems into broader cap and trade climate mitigation, mindful of the dependency of such programs on transparency.

Venting natural gas before or after well preparation appears to still present a transparency challenge of unknown, but knowable dimensions, if regulations were to be expanded to methane emissions across the natural gas life cycle. Burning methane as fully as possible increases the transfer of methane to carbon dioxide, which is a substantial greenhouse gas contributor in its own right, but less potent than

---

wire/rss/2012/03/15/3 ("Old plastic pipes, poor record-keeping, unauthorized digging and a host of other problems put natural gas pipelines at risk for rupture and explosion, the California Public Utilities Commission said yesterday.").

131. *E.g.*, Juliet Eilperin, *Natural Gas Leaks Come Under Scrutiny, Raise Questions on Climate Impact*, Wash. Post, Mar. 3, 2013, http://www.washingtonpost.com/national/health-science/natural-gas-leaks-come-under-scrutiny-raise-questions-on-climate-impact/2013/03/03/23d1e0d4-7f88-11e2-b99e-6baf4ebe42df_story.html ("While aging infrastructure contributes to leaks, so does the fact that utilities in Boston and the District can pass on the full cost of unaccounted losses—whether through leaks or theft—to customers. In the District, this charge makes up 3 percent of Washington Gas customers' monthly costs; in Boston it represents 1 percent of residents' monthly bill, the companies say.").

methane. Burning natural gas, which is primarily methane, produces less carbon dioxide than burning coal, but methane has a greenhouse heating effect over twenty times greater than that of CO_2, so substantial methane leaks could entirely counter the benefits increased natural gas use. Due to the vast reserves of natural gas now recoverable through unconventional methods and made more profitable by recent technological and legal developments, energy momentum has veered in the direction of maximizing natural gas extraction. The effect on renewables appears to be a negative one, raising the question of whether market intervention should be undertaken by the public sector. The trade-offs are public health and ecosystem services that can be gained by protecting public goods to air and water versus economic stimulation, energy access, and private property rights benefited from a thin legal mantel over natural gas development.

We do not know what we are consuming. Only since 2011 have we begun to look at aggregate oil and natural gas data by state, and are now able to pinpoint geographical locations of sources and suppliers. We have yet to coordinate robust life cycle analysis that parses out why some traditional oil and gas states have low emissions, while states that do not feature largely in the hydraulic fracturing debate have surprisingly high emissions. Further elements in a matrix, beyond direct methane emissions and renewable portfolio standards, could involve a vulnerability ranking by state. Whether within the same or a new category, some assessment of disaster locations could be illuminating. Here it would be important to differentiate among rapid-onset disasters such as Katrina and Sandy versus slow-onset disasters such as extreme drought.[132] Do declarations of disaster jurisdictions correlate with subsequent climate sensitivities, leading to greater incentivizing of a shift from fossil fuels to renewables? Another element in a climate-energy-water matrix that could be useful to mapping the evolving sustainability challenge is tracking the industry's degree of good-faith reporting of methane emissions through neutral, infrared monitoring. It would also be useful to map which states rely to a greater degree on oil, coal, natural gas, geothermal, hydro, nuclear, and renewables. While most decision makers have a general sense of heating differentials based on northern states' winter temperatures being lower than those further south, recent warmer winters and summers have had a ripple effect,

132. *See, e.g.*, *Disaster Declarations*, FEMA, http://www.fema.gov/disasters (last visited Apr. 3, 2013) (distinguishing between types of severe disasters); *see also* Elizabeth Burleson, *Field Notes from the SuperStorm Sandy Catastrophe,* 37 Colum. J. Envtl. L. (forthcoming 2013) (discussing the large-scale impact of sudden onset Super-Storm Sandy); Elizabeth Burleson, *Climate Change Displacement to Refuge*, 25 J. Envtl. L. & Litig. 19 (2010) (discussing how climate change and weather disasters impact migration patterns and refugees).

impacting energy supply and demand cycles as the climate becomes more unpredictable from season to season and year to year.

In addition to demand-end elements broken down by state, mapping supply infrastructure could also illuminate where states have greater capacity to bring natural gas to market without flaring. The low natural gas emissions reported by Texas in the above chart likely results, at least in part, from its existing extensive pipeline and refinery infrastructure—but it would be useful to differentiate where existing infrastructure plays the major role in averting flaring versus where gas development is happening by emitters producing under the 25,000 metric ton CO_2e threshold or emitting in ways that are indirect and thus not covered by current reporting requirements.

Given U.S. federal capacity, the EPA is well positioned to coordinate further information gathering that could flesh out these elements of climate-energy-water governance innovation. With enhanced reporting and implementation requirements to reduce methane emissions throughout the natural gas lifecycle, the U.S. federal government can cooperatively facilitate the balancing of energy access and oversight with civil society, industry, municipalities, tribes, and states.

B. North Dakota Leads the United States in Growth at What Cost to Climate?

Every day North Dakota flares natural gas that could heat half a million homes for a day.[133] While natural gas developers in the Marcellus Shale region go to great lengths to reach the gas,[134] developers in North Dakota's Bakken prefer the higher revenue stream of crude oil and are treating the gas as waste. It is not clear whether this approach will also occur in other states as natural gas

133. Andrew C. Revkin & Clifford Krauss, *A Cheap, Easy Way to Curb Climate Change: Seal the Gas Leaks*, N.Y. Times, Oct. 15, 2009, at A1 ("For the EPA and environmental scientists, the challenge is convincing gas and oil producers here and abroad that efforts to avoid such releases often more than pay for themselves. The use of infrared cameras is expanding as word spreads of the payoff in saved gas.").

134. *See* Janice Crompton, *Flares from Marcellus Shale Wells Attracting Plenty of Attention*, Pittsburgh Post-Gazette, (Feb. 2, 2012, 12:00 AM), http://www.post-gazette.com/pg/12033/1207351-59.stm (detailing the process by which gas is reached and the reasons for using flares); *Tensions Flicker over Marcellus Flaring*, EEnews Greenwire (Feb. 7, 2012), http://www.eenews.net/Greenwire/rss/2012/02/07/17 ("Flaring occurs after the hydraulic fracturing process to test the well. It is also used to release pressure before production begins. The process takes about three days."); Anna Driver & Bruce Nichols, *Shale Oil Boom Sends Waste Gas Burn-Off Soaring*, Reuters (July 25, 2011, 2:18 PM), http://www.reuters.com/article/2011/07/25/us-shale-flaring-idUSTRE76O4SU20110725 (noting that flaring of natural gas substantially adds to global warming).

prices sink and oil prices remain high. The more remote the well, the harder it is to connect it to existing natural gas pipelines—a problem that has increased as hydraulic fracturing expands into new areas. The U.S. Energy Information Administration explains:

> The North Dakota Department of Mineral Resources estimated that in May 2011, nearly 36% of the natural gas produced did not make it to market. Most of this gas—29% of the total gas produced—was flared. The remaining natural gas that did not make it to market—7% of total gas produced—is unaccounted for or lost, which means the gas may have been used as lease and plant fuel, or encountered losses during processing or transportation. . . .
>
> According to current North Dakota state regulations, producers can flare natural gas for one year without paying taxes or royalties on it, and can ask for an extension on that period due to economic hardship of connecting the well to a natural gas pipeline. After one year, or when the extension runs out, producers can continue flaring but are responsible for the same taxes and royalties they would have paid if the natural gas went to market.[135]

For the United States, North Dakota flaring is an industry outlier, but a significant one in the context of climate stability. North Dakota's relative remoteness does not mean it contributes less to climate destabilization—greenhouse gasses distribute evenly in the atmosphere. Michael Webber, of the University of Texas Center for International Energy and Environmental Policy, notes that "North Dakota is not as bad as Kazakhstan, but this is not what you would expect a civilized, efficient society to do: to flare off a perfectly good product just because it's expensive to bring to market."[136] If Bakken drillers cannot afford to do something more productive with the natural gas that they are extracting than flare, then the public sector should intervene to fix this market failure and increase the value of methane emission mitigation.

135. *Over One-Third of Natural Gas Produced in North Dakota Is Flared or Otherwise Not Marketed*, *supra* note 43; *see also* Julia Sklar, *Gas Flares from Bakken Fracking are Visible from Space,* NEW SCIENTIST (Jan. 28, 2013, 5:20 PM), http://www.newscientist.com/blogs/shortsharpscience/2013/01/julia-sklar-reporter.html ("[A] town with a different kind of night-life. One of the bright regions that sits alone in the darkness of the northern plains isn't a bustling city at all—instead, this blaze is a night-time view of fracking in action. Seen in this photo taken by NASA's Suomi NPP satellite, the glow comes from hundreds of flares from rigs drilled into the Bakken formation of North Dakota.").

136. Revkin & Krauss, *supra* note 133.

Even if the United States is unlikely to directly alter the price of natural gas, it can indirectly alter the price of polluting the atmosphere with what drillers perceive to be excess natural gas. High oil prices combined with short, five-year leases to drill in the Bakken have the oil and gas industry acting wastefully with regard to the long-term value of natural gas and climate stability. The last time the federal government addressed flaring was when it required Alaska North Slope reinjection rather than flaring in the 1970s. If remote Saskatchewan can enact flaring standards,[137] then states like North Dakota can coordinate with the federal government to effectively end large-scale flaring. Coordination can also include such companies as Whiting, given its experience reducing flaring from 80 to 20 percent by building gas plants.[138] Solution generation does not need to be as one dimensional as piping gas to distant markets. It does not require siting new natural gas plants per se. Innovating other ways to either put the methane back underground or use it more responsibly can occur through state and non-state networks committed to genuine climate stabilization.

Locating entities that could soak up demand could work both as a solution and a way of bringing natural gas to areas in need of it. Since neither of these two ideas is likely to be implemented quickly, reinjecting and powering operations should be seriously considered, as they could be done without substantial additional infrastructure by creating regulations that incentivize industry internalization of the methane contribution to climate destabilization.

Over the course of a single year, North Dakota's flaring has contributed at least two million tons of carbon dioxide toward climate destabilization.[139] While a few pipelines are underway to connect some wells, the Bakken oil field encompasses 18,000 square miles and is not

137. *See* Memo from Todd H. Han, Director, Petrol. Dev. Branch, Ministry of Energy & Res., Sask., to Sask. Well and Facility Licensees, regarding Introduction of Directive S-10, *Saskatchewan Upstream Petroleum Industry Associated Gas Conservation Directive* and Directive S-20, *Saskatchewan Upstream Flaring and Incineration Requirements* (June 22, 2011), *available at* http://www.economy.gov.sk.ca/NTAO-S10-S20 (announcing the introduction of new gas conservation standards). *See generally* Joshua P. Fershee, *The Oil and Gas Evolution: Learning from the Hydraulic Fracturing Experiences in North Dakota and West Virginia*, 19 TEX. WESLEYAN L. REV. 23 (2012).

138. David Fessler, *Bakken Natural Gas Flaring: A Giant Step Backward or an Opportunity in Disguise?*, INVESTMENT U. (Sept. 30, 2011), http://www.investmentu.com/2011/September/natural-gas-flaring.html.

139. Jan Falstad, *Gas to Greenbacks: Montanans Create Company to Capture, Sell Excess Bakken Gas*, BILLINGS BUS. (June 10, 2012, 12:10 AM), http://billingsgazette.com/business/montanans-create-company-to-capture-sell-excess-bakken-gas/article_85e40396-3ae0-5cc1-8cf9-5b8e8fbce30b.html.

recognized as a productive natural gas play despite its ability to be liquefied.[140] To my mind, North Dakota is in a position to incentivize green technology that captures natural gas. This can be done through banning flaring just as Nigeria has done, albeit with insufficient enforcement. It can be done through a state renewable portfolio standard that factors flaring reduction into a target flexibility mechanism. This could be achieved by linking cap and trade programs to put a price on greenhouse gas emissions, or it could be done by taxing greenhouse gas emissions.[141] As this article goes to press, North Dakota Govenor Jack Dalrymple has signed legislation that offers oil producers tax breaks in exchange for reducing natural gas flaring in the northwest part of the state.[142] Generally, the new law seeks to incentivize wells over one year old to stop flaring and either be capped or connected to a gas gathering line. It remains an open question the degree to which oil producers will make use of the new rule's inclusion of an exemption request to the state's industrial commission based on economic infeasibility.[143]

In the governance gap that has led to excessive North Dakota flaring, entrepreneurial innovators have seen an independent economic opportunity "creating wealth from a waste stream."[144] An initiative called G2G has a trailer gas liquefying service that leaves the well owner with the end product to use or sell. Since methane requires a great deal of pressure to liquefy, G2G has been using methane to power the process of liquefying other gasses. Rather than flaring, there are markets for propane, butane, and natural gasoline that can be separated from the natural gas, which in and of itself, has been a valuable home heating fuel. Flaring is shortsighted given the greater

140. *Id.*

141. *See* Mike Ellerd, *PN Bakken: Legislation Provides Incentives for Gas Flaring Alternatives*, Petroleum News Bakken (Jan. 20, 2013), http://www.petroleumnews.com/pntruncate/237468870.shtml ("House bill 1134 identifies additional alternatives to keep gas from 'going up in flames,' and offers tax incentives to reduce flaring.").

142. Mark Wolski, *Drilling: North Dakota Governor Signs Bill Offering Tax Breaks to Reduce Gas Flares*, 85 Daily Env't Rep. (BNA) A-6 (May 5, 2013), *available at* http://news.bna.com/deln/DELNWB/split_display.adp?fedfid=30888938&vname=dennotallissues&jd=a0d8c5m5u3 ("The bill (H.B. 1134), which was signed April 26, exempts tangible personal property used to collect natural gas from wells from the state's sales tax, while also exempting natural gas collected from oil wells from the gross production tax.").

143. Information on North Dakota's H.B. 1134, which becomes effective July 1, 2013, is available at http://www.legis.nd.gov/assembly/63-2013/bill-index/bi1134.html.

144. Falstad, *supra* note 139 ("Depending on the well, G2G's technology can capture up to three-fourths of the natural gas liquids and provide another revenue source for well and mineral rights owners.").

value of cogeneration of electricity combining plentiful natural gas and wind power. This need not rely entirely on electrical wires for transmission infrastructure given the possible option to use the Missouri and other rivers for energy storage. Hydro-wind-natural gas cogeneration could innovatively power the region with sufficient public-private investment and coordination.

When I taught energy law in the Dakotas, my students and I submitted comments for a hydro-wind tribal proposal on the Missouri River that was initiated by the Energy Policy Act of 2005.[145] Teaching energy, water, climate, property, international, intertribal, environmental law in the Dakotas taught me to appreciate constant wind and deepened my understanding of the energy and political spectrum. Softball sized hail and forty below temperatures did not deter me from spending significant time enjoying the night sky—a distinct contrast from the often too light skies with which I had grown up. I am reminded of a ten-year-old child from New York City who once asked me what all the spots in the night sky were. Unlike this child from Harlem, I did know what stars were. The opportunity to see such bright stars, however, is well worth lingering in the Dakotas to appreciate. During the northeast power outage of 2003 and increasing power outages since, neighbors congregate on sofa cushions in my Connecticut backyard, and we point out constellations that ordinarily one would have to drive significantly further north than NYC commuter land to have seen well. Light pollution has long been appreciated by astronomers and recently recognized as harmful by medical professionals studying sleep patterns.[146] If all that resulted from flaring was light pollution, perhaps the trade-off of a striking Dakota sky would be seen as a luxury *vis-à-vis* energy access and economic stimulation. Yet light pollution is not the only ramification of flaring. We understand greenhouse gases well enough to render it short sighted to flare on this scale.

It is hard to want to suffer being above or below an individual temperature comfort zone to reduce greenhouse gases collectively,

145. W. AREA POWER ADMIN., WIND/HYDRO FEASIBILITY STUDY (WHFS) 1 (2007), *available at* http://www.wapa.gov/ugp/powermarketing/windhydro/FINAL%20WHFS%20WorkPlan%2011_05.pdf ("The Energy Policy Act of 2005, Sec. 2606, required a study be performed by the Department of Energy (DOE) involving wind-hydro integration. Western Area Power Administration (Western) was tasked by DOE to perform a study of cost and feasibility to develop a demonstration project that uses wind energy generated on Indian Tribal lands and Federal hydroelectric power generated on the Missouri River to supply firming power to Western to meet its contractual obligations.").

146. Denise Winterman, *Light Pollution: Is There a Solution?*, BBC NEWS MAG. (Jan. 17, 2012, 8:53 PM), http://www.bbc.co.uk/news/magazine-16470744.

when corporations are irresponsibly venting and flaring natural gas at rates visible on NASA satellite nighttime images of locations such as North Dakota's Bakken Play. This collective action problem has been written about with regard to Harden's sheep, forestry and fishery management, sulfur dioxide impacts on acid rain, and the broad economic literature on the prisoner's dilemma and free riding. Free riding connotes inaction that benefits from the efforts of others. Yet, flaring is an active black eye in U.S. efforts to respond effectively to climate change. This is not a complex problem lacking a technical solution. It is an economic calculation of revenue maximization absent a clear price on greenhouse gases and their externality impacts ranging from Super Storms on the scale of Sandy to continental droughts.

Since negative externalities to the global atmospheric commons are not internalized in the cost of natural gas development, wells that are not close to pipelines and unlikely to be hooked up, and wells that are hooked up but have encountered pipelines that are full, have limited but viable alternatives to monetize the natural gas rather than flare roughly 30 percent of production. Given the scale of flaring, market adjustment should be occurring. For instance, fertilizer production does not require extensive pipeline infrastructure and can greatly benefit from low natural gas prices. If a fertilizer renaissance can ramp up and down with the swings in North Dakota isolated natural gas availability, it could help respond to growing demand for increased fertilizer. Utilizing a gas glut is not a roller coaster ride that all market participants are interested in, but those with sufficient flexibility could benefit greatly from low material costs and high fertilizer demand. Given a constrained national budget, it is worth questioning whether the dead zone in the Gulf of Mexico that has been created largely due to fertilizer runoff should have offset the July 2012 decision by the North Dakota Department of Commerce to award the Northern Corn Development Corporation $100,000 to bring online a fertilizer sector to sop up a natural gas glut and avert Bakken flaring.[147] While a broad debate has occurred over biofuels and

147. John Kemp, *Fertilizer Could Provide Solution to Bakken Flaring*, Reuters (Sept. 26, 2012, 7:26 AM), http://www.reuters.com/article/2012/09/26/us-column-kemp-usfertiliser-idUSBRE88P0P620120926 ("Nitrogen is an essential part of all plant and animal proteins. While a few crops such as peas and soybeans can 'fix' nitrogen directly from the air, most, including wheat and corn, rely on nitrogen uptake from the soil from decomposing animal and plant waste or commercially produced fertilizers. . . . [N]itrogen-base fertilizers are [generally] produced by reacting nitrogen from the air with hydrogen sourced from natural gas to produce ammonia. . . . The world's biggest producers last year were China (41 million metric tonnes by nitrogen content), India (12 million metric tonnes)[,] Russia (11 million metric tonnes)[,] and the United States (8.1 million metric tonnes).").

food security, fewer members of the general public are aware that fertilizer prices track natural gas prices given that natural gas represents 80 to 90 percent of fertilizer production costs.[148] Coordination between states and non-states can help flesh out the relative merits of flaring *vis-à-vis* alternative uses of natural gas as well as innovate break out energy access solutions through collaboration not only in research but also in commercialization stages of the innovation process.

The standard use of natural gas is to pipe it to businesses and residences for heat and cooking fuel. Life-cycle analysis that compares natural gas to both traditional and renewable energy sources need to remain mindful that electricity is not the only use for natural gas—no matter how convenient a metric electricity provides in conducting life-cycle analyses. It is useful to have apples and apples at the end of the calculation, but not if doing so requires ignoring an end use on the scale of natural gas home heating which has nothing to do with electricity for many consumers.

That said, the United States needs robust and comprehensive life-cycle analysis to overcome the gridlock that has been largely political for lack of enough information to engage in nuanced analytical dialogues. If the Keystone XL pipeline is built from western Canada to refineries on the U.S. Gulf Coast, then a portion of natural gas can be used to dilute the heavy bituminous crudes.[149] Again, the reduction of flaring should not be the only consideration in incentivizing tar sand transport from Canada. Broader climate-energy-water considerations need to be analyzed in an economic-social-environmental balancing that is mindful not only of the recent economic downturn but also social and environmental integrity. A chart or several charts making up an energy matrix would be very useful for the general public to be able to see the energy-water-climate intensity of tar sands at one end of the spectrum and perhaps wind or wave energy at the other end of the spectrum. Time has been wasted not gathering far more information with which to make informed decisions among cross-cutting issues.

Until recently, the *New Scientist* would probably not be running articles with titles like *Gas Flares from Bakken Fracking are Visible from Space*.[150] Yet sometimes a visual really does outweigh reports, particularly technical ones full of numbers about drilling mud and

148. *Id.*

149. While the Keystone XL pipeline has been embraced by some, others have been less eager about the possibility. *See* Dan Frosch, *Last-Ditch Bid in Texas To Try to Stop Oil Pipeline*, N.Y. TIMES, Oct. 13, 2012, at A14 (discussing the ongoing battle in Texas over the Keystone XL, noting TransCanada's behavior and pushback from Texans).

150. Sklar, *supra* note 135.

such. NASA's Suomi NPP satellite image of the U.S. night sky is now spreading like wildfire across the Internet through mainstream and social media networks. One could be forgiven for thinking the bright light the size of metropolitan Boston was an enormous wildfire. But it is not. Flaring roughly a third of natural gas production has lit up North Dakota—a sight now within a click of a mouse for anyone with an Internet connection. Transparent it is—disinfecting sunlight it is not. The climate ramifications of such greenhouse gas emissions are only now being discussed as the general public starts putting the pieces of climate destabilization together.

State incentives through fiscal carrots or sticks combined with mandatory standards can help industry internalize the costs of faulty equipment, corrosion in pipelines, loose valves, and other natural gas infrastructure weak links where methane emissions can be expected and should be minimized.

Infrared lenses and satellites can help industry, regulators, and the general public see escaping methane.[151] Rendering methane emissions a visible and targeted challenge can help incentivize methane capture. Through computer monitoring, BP was able to track well pressure and time plunger lift cycles, cutting measured methane emissions in half by 2004 and almost entirely by 2007. The costs were one third of the captured natural gas revenues. This approach cannot offset unsafe practices elsewhere in the production line, nor does it always address ground-to-sale-meter natural gas emission, but it can noticeably reduce methane leakage.[152]

State departments of environment and natural resources, in North Dakota and elsewhere, are in a position to set emission floors above which drillers cannot exceed. Instead, unconventional natural gas plays are outstripping the pollution levels of major U.S. cities, and authorities are requesting that members of the general public stay inside. "I don't think we have to sell out our health for economic

151. *See, e.g.*, *Car-Mounted Sensor Able to Pinpoint Sources of Natural Gas Leaks*, YALE ENV'T 360 (Dec. 14, 2012), http://e360.yale.edu/digest/car-mounted_sensor_able_to_pinpoint_sources_of_natural_gas_leaks/3719/ ("A U.S.-based company has developed a sophisticated sensing technology capable of detecting and pinpointing the source of even minor natural gas leaks from great distances, an innovation that could provide critical insights into the still largely unknown climate impacts of natural gas drilling. . . . As natural gas drilling rapidly expands globally, driven by hydraulic fracturing technology, sophisticated methane detectors could provide important data on just how that drilling could contribute to climate change.").

152. *See* Revkin & Krauss, *supra* note 133, at A1 ("For the EPA and environmental scientists, the challenge is convincing gas and oil producers here and abroad that efforts to avoid such releases often more than pay for themselves. The use of infrared cameras is expanding as word spreads of the payoff in saved gas.").

survival here. One shouldn't be a tradeoff for the other," according to Elaine Crumpley, a Wyoming environmentalist.[153] The cost of polluting is as important as the cost of capturing emissions and internalizing environmental externalities that are shifted from private industry to the general public in the form of air and water contamination. State public sector regulations, taxes and subsidies, renewable portfolio standards, and cap and trade participation can help natural gas developers internalize the costs of production generally and justify up-front investments in methane mitigation in the face of competing capital costs and quarterly return timeframes for shareholder profit.[154]

The next Section considers the role that non-state actors such as universities are playing in such dynamic governance. Professors at Cornell and elsewhere are struggling to come to terms with whether natural gas should become a bridging fuel.[155] The Section considers some of the information that has emerged, and concludes that assumptions matter and dynamic governance coordination can facilitate closing the substantial information gap on natural gas climate impacts in relation to the full spectrum of energy options.

C. University Innovation Leadership?

Hydraulic fracturing and related unconventional natural gas development release significant methane emissions into the atmosphere. The main component of natural gas is the potent greenhouse gas methane. The greenhouse gas footprint of natural gas development includes "direct emissions of CO_2 from end-use consumption, indirect emissions of CO_2 from fossil fuels used to extract, develop, and transport the gas."[156] According to Cornell Professor Robert Howarth, Shale gas production is projected to rise from 16 percent of U.S. fuel

---

153. Mead Gruver, *Enviros Threaten to Sue EPA over Pollution in Gas Drilling Region,* EENEWS GREENWIRE (Oct. 4, 2011), http://www.eenews.net/Greenwire/rss/2011/10/04/20.

154. *See, e.g.*, Jean-Philippe Brisson, Stanford Renas & Daniel Firger, *California's Cap-and-Trade Regulations: Design Elements and Outstanding Issues*, BLOOMBERG BNA (Dec. 23, 2011), http://news.bna.com/erln/ERLNWB/split_display.adp?fedfid=23904392&vname=ernotallissues&fn=23904392&jd=a0d0a9m5k3&split=0 ("[C]overed entities can meet up to 8 percent of their compliance obligation by surrendering CARB offset credits.").

155. *See* Robert W. Howarth & Anthony Ingraffea, *Should Fracking Stop?*, 477 NATURE 271 (2011), *available at* http://www.nature.com/nature/journal/v477/n7364/abs/477271a.html (narrating the debate over whether fracking is too high risk of an activity to continue, or whether it is too valuable to stop).

156. Robert W. Howarth, Renee Santoro & Anthony Ingraffea, Letter, *Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations*, 106 CLIMATIC CHANGE 679, 680 (2011).

production to 45 percent between 2009 and 2035.[157] While natural gas does not have as concentrated byproducts as coal (for example, ash, mercury, sulfur, and other particulates),[158] too "little is known about the [greenhouse gas] footprint of unconventional gas."[159] I argue that the national academies should be much more involved in mapping the impacts of hydraulic fracturing. This would provide highly credible information with which to make collective energy policy decisions across the complex array of energy sources.

Already the National Research Council is on record for projecting that natural gas emissions could exceed conventional gas. A letter to President Obama from the Council of Scientific Society Presidents explains that unconventional natural gas extraction is not yet sufficiently understood to conclude whether its use will increase or decrease climate mitigation.[160] While there is a broad international consensus that urgent energy policy shifts are requisite to mitigate greenhouse gas emissions, scientific consensus has yet to coalesce on the impacts of unconventional natural gas development *vis-à-vis* other energy options.

Two recent academic studies on methane release from unconventional natural gas extraction have reached opposite conclusions.[161] First and foremost, to my mind this indicates that the public sector should facilitate robust scientific study before further natural gas development proceeds. Second, faced with profound climate-energy-water uncertainty, collective decision making should be inclusive, transparent, and representative in order to balance economic, social, and environmental needs and rights.

With regard to the first priority, three core categories are important to understanding the greenhouse gas footprint of unconventional natural gas development:

1) Combustion of fossil fuels to drive the engines of the drills, pumps and compressors, etc, required to extract natural gas

157. *Id.*

158. Lawrence M. Cathles III et al., *A Commentary on "The Greenhouse-Gas Footprint of Natural Gas in Shale Formations" by R.W. Howarth, R. Santoro, and Anthony Ingraffea*, 113 CLIMATIC CHANGE 525, 525 (2012).

159. Howarth, Santoro, & Ingraffea, *supra* note 156, at 680.

160. Letter from Council of Scientific Soc'y Presidents to President Obama & Senior Admin. Officials (May 4, 2010), *available at* http://www.eeb.cornell.edu/howarth/CCSP%20letter%20on%20energy%20&%20environment.pdf; NAT'L RESEARCH COUNCIL, HIDDEN COSTS OF ENERGY: UNPRICED CONSEQUENCES OF ENERGY PRODUCTION AND USE (2010).

161. *Compare* Howarth et al., *supra* note 156, *with* Cathles et al., *supra* note 158.

onsite, and to transport equipment, resources and waste on and off the well site;

2) Fugitive emissions are emissions of natural gas that escape unintentionally during the well construction and production stages; and

3) Vented emissions result from natural gas that is collected and combusted onsite or vented directly to the atmosphere in a controlled way.[162]

Fugitive methane emissions and direct CO_2 emissions appear to be of greatest climate concern.[163] While the Howarth et al. study remains the most high profile analysis on climate impacts of unconventional natural gas development,[164] Cathles et al. have challenged the study,[165] arguing that "the greenhouse impact of natural gas is only as bad as coal if a very high methane leakage rate of 7.9% and a short global warming impact period of 20 years are selected."[166] With a smaller estimate of gas leakage rates and a hundred-year timeframe, natural gas appears to have a smaller global warming impact than coal.[167] Due to the varying periods of time that carbon dioxide and methane impact climate change, it matters whether one considers a twenty-year versus hundred-year timeframe. In a twenty-year timeframe, the short-lived climate forcer methane will have a comparatively larger impact than over the hundred-year timeframe. Beyond this difference, it is fair to say that insufficient modeling has been conducted to date to truly understand the greenhouse gas footprint of cradle to grave unconventional natural gas development.

---

162. Ruth Wood et al., Tyndall Centre Manchester, Shale Gas: A Provisional Assessment of Climate Change and Environmental Impacts 38 (2011).

163. *See* Overview of Final Amendments to Air Regulations for the Oil and Natural Gas Industry, *supra* note 6, at 3 (hydraulic fracture flow-back brings up significant quantities of methane, VOCs, benzene, ethylbenzene, and n-hexane).

164. For another study on air emissions, see Gabrielle Pétron et al., *Hydrocarbon Emissions Characterization in the Colorado Front Range: A Pilot Study*, 117 J. Geophysical Res. D04304 (2012).

165. *See* Cathles et al., *supra* note 158, at 525 (arguing that the study's analysis was seriously flawed for a variety of reasons); Nathan Hultman et al., *The Greenhouse Impact of Unconventional Gas for Electricity Generation*, 6 Envtl. Res. Letters 044008 (2011), *available at* http://iopscience.iop.org/1748-9326/6/4/044008/pdf/1748-9326_6_4_044008.pdf (examining the use of global warming potential values in the Howarth paper).

166. Cathles et al., *supra* note 158, at 528.

167. *Id.*

Mark Fulton et al.[168] explain that the EPA has until recently assumed natural gas has been captured but is now revising its calculations to consider the scale of methane emissions that have yet to be captured.[169] They note that "[t]hese revisions have caused some to question whether replacing coal with natural gas would actually reduce GHGs, when emissions over the entire life cycles of both fuels are taken into account."[170] Addressing these questions requires an understanding of a number of factors for which there is currently insufficient information.[171] Similarly, the Jiang et al. study focused only on "[h]ydraulic fracturing associated GHG emissions [that] result from the operation of the diesel compressor used to move and compress the fracturing fluid to high pressure, the emissions associated with the production of the hydraulic fracturing fluid, and from fugitive methane emissions as flowback water is captured."[172] This does not consider the broader methane emissions from the entire natural gas system. Furthermore, most recent studies other than the Howarth study have used the IPCC hundred-year global warming potential rather than the twenty-year timeframe that Howarth used to account for the greater intensity and short lived nature of methane over carbon dioxide.[173]

O'Sullivan and Paltsev estimate that the U.S. natural gas value chain emitted more than 3 percent of national fugitive methane and that "for the vast majority of contemporary shale gas wells, the

168. Mark Fulton et al., Comparing Life-Cycle Greenhouse Gas Emissions from Natural Gas and Coal 28 (2011) ("Going from the 100 year GWP [global warming potential] to the 20-year GWP of 72 increases life-cycle emissions for natural gas by 31 percent and for coal by only 6 percent. At the GWP of 72, the power plant emissions for natural gas are 35 percent lower than those for coal. At the 105 GWP, the emissions for the gas-fired plant are 27 percent lower than those for coal.").

169. *Id.* at 7 ("The bulk of the EPA's recent upward revisions of natural gas emissions estimates are related to the production part of the gas value chain. . . . The revisions also include an increase in the share of gas that is produced from hydraulically fractured shale gas wells and a change in the assumption as to how much of the flow-back emissions are flared. Previously, the EPA assumed that 100 percent of these emissions were flared or captured for sale. The new estimate assumes that approximately one third are flared and another third are captured through 'reduced emission completions.'").

170. *Id.*

171. *Id.*

172. Mohan Jiang et al., *Life Cycle Greenhouse Gas Emissions of Marcellus Shale Gas*, 6 Envtl. Res. Letters 034014, at 5, *available at* http://iopscience.iop.org/1748-9326/6/3/034014/pdf/1748-9326_6_3_034014.pdf.

173. *See id.* at 2 ("We use the 100-year GWP factor, in which methane has a global warming potential (GWP) 25 times higher than carbon dioxide." (citation omitted)).

revenues gained from using reduced emissions completions to capture the gas produced during a typical flowback cover the cost of executing such completions."[174] Rather than assuming that all emissions are vented, as they view Howarth's calculations, or assuming that 93 percent of potential fugitive emissions are captured by industry as ANGA did, O'Sullivan and Paltsev assume that "70% of potential fugitives are captured, 15% vented, and 15% flared."[175]

Skone et al. explain that determining relative coal–natural gas greenhouse gas intensities depends upon a range of uncertainties including natural gas use and emission during transmission, well completion, and the estimated well lifespan.[176] It also matters whether

174. FRANCIS O'SULLIVAN & SERGEY PALTSEV, MIT JOINT PROGRAM ON THE SCI. & POL'Y OF GLOBAL CHANGE, SHALE GAS PRODUCTION: POTENTIAL VERSUS ACTUAL GHG EMISSIONS 7 (2012); *see also id.* at 2 ("The economic production of shale gas is only possible through the use of hydraulic fracturing to increase production rates from the extremely low-permeability shale formations. The hydraulic fracturing process has two main stages: injection and flowback. During injection, a slurry made up of a carrier fluid, typically water, and a proppant agent, typically sand, is forced into the well at pressures significant enough to induce fractures in the reservoir rock. These propped fractures allow gas in the formation to flow from the well at economically acceptable rates. After the injection phase is completed, flowback takes place. Here some of the initially injected fluid returns to the surface over the course of a week or more. During flowback, the well also begins to produce gas. It is the amount of this gas, and how it is handled, that has been central to the debate about the GHG intensity of shale development.").

175. *Id.* at 6; *see also id.* at 7 ("If the cost of reduced emission completion is $1,000 per day as stated by Devon (2008), 95% of the 2010 Barnett wells yielded positive net revenues, i.e. operators added to the value of their wells by capturing the potential fugitive emissions. Even at twice this reported capture cost, $2,000 per day, 83% of the 2010 Barnett wells would still positive net revenues, and this trend is repeated in . . . all the other shale plays."); Ramón A. Alvarez et al., *Greater Focus Needed on Methane Leakage from Natural Gas Infrastructure*, 109 PROC. NAT'L ACAD. SCI. 6435, at S7 (2012) ("The main difference is that Howarth et al. [2011] assume much greater methane emissions than we do. As described above, we estimate that 2.1% of natural gas produced is lost annually between the well and the power plant (including the local distribution system, we estimate that the natural gas emitted is 2.4% of gross natural gas production). Howarth et al. [2011] used a range of 3.6–7.9% for shale gas and 1.7–6.0% for conventional gas (as a percentage of the CH_4 produced over the lifecycle of a well . . . .").

176. TIMOTHY J. SKONE ET AL., NAT'L. ENERGY TECH. LAB., LIFE CYCLE GREENHOUSE GAS INVENTORY OF NATURAL GAS EXTRACTION, DELIVERY AND ELECTRICITY PRODUCTION 38 (2011).

electricity, home heating fuel, or some other use is specified as an end use.[177]

While few members of the general public individually have expertise spanning the scientific, technical, legal, economic, and social ramifications of internalizing the cost of greenhouse gas emissions, the national academies are well positioned to provide credible new information with which to make collective and inclusive energy policy decisions across the complex array of energy sources.

Conclusion: Dynamic Governance Recommendations

Energy decision making need not be truncated into a chase-our-tail discussion over the relative merits of two forms of fossil fuel (natural gas and coal), ignoring all other energy-climate-water considerations. The United States National Academies are well positioned to lead an expanded and intensified series of spotlight studies until we have a well-lit picture of unconventional natural gas production—*before* proceeding. I argue that the discussion should be broadened beyond a water pollution[178] and coal comparison discussion to a solution-generation initiative that encompasses minimizing natural gas emissions, enhancing offshore renewable options such as wave power, and governance innovation, including linking cap and trade programs.

---

177. *See id.* ("[A]verage coal, across a wide range of variability, and compared across different assumptions of climate impact timing, has lower greenhouse gas emissions than domestically produced natural gas when compared as a delivered energy feedstock—over 50 percent less than natural gas per unit of energy. However, the conclusion that coal is the cleaner fuel flips once the fuels are converted to electricity in power plants with different efficiencies—53 percent for natural gas versus 35 percent for coal. Natural gas-fired electricity has a 42 percent to 53 percent lower climate impact than coal-fired electricity. Even when fired on 100 percent unconventional natural gas, from tight sands, shale and coal beds, and compared on a 20-year GWP, natural gas-fired electricity has 39 percent lower greenhouse gases than coal. This shifting conclusion based on a change in the basis of comparison highlights the importance of specifying an end-use basis—not necessarily power production—when comparing different fuels.").

178. *See Love Canal City Looks into Accepting Drilling Wastewater*, EENews Greenwire (Oct. 21, 2011), http://www.eenews.net/Greenwire/rss/2011/10/21/21 ("Niagara Falls, N.Y., is looking into accepting hydraulic fracturing wastewater to spur its limping economy. The Niagara Falls Water Board says it has the specialized wastewater treatment plant for the job and could use more business now that the chemical industry has declined. . . . Environmentalists, including Lois Gibbs, who led the charge against toxic contamination at Love Canal, are critical of sending more chemicals to the region. The Love Canal incident at Niagara Falls spurred the creation of the federal Superfund program.").

I recommend enhancing disclosure requirements for the full range of data necessary to generate lifecycle analysis, including industry wide greenhouse gas emissions rates. This can be done at the stage of participating in the stock market, obtaining insurance, qualifying for public subsidies before receiving tax advantaged status, amendments to existing environmental statutes such as the Clean Air Act, or by EPA rulemaking—just to mention a few approaches. Given the international nature of the climate collective action problem, such legal requirements could be written into the climate instrument that countries have recently committed to ratifying by 2020.[179] A Rip Van Winkle siesta until then is not advisable; there is a need for local momentum to continue to propel environmentally sound decisions into the constrained market place. Local impacts in the form of cancer spikes in given communities allow ordinary citizens to highlight the inequity of allowing large corporations to continue to externalize pollution costs. Neighboring communities care about both steady employment and averting terminal illnesses as a result of exposure to contaminants.

At present, the federal government does not even know how much methane is being released on federal lands. Congressmen Markey and Holt argued in a letter to then–Interior Secretary Ken Salazar that scant fines do not deter drillers from minimizing unsafe operations. The congressmen urged Salazar to apply fines transparently, uniformly, and at a level capable of altering corporate incentives to internalize negative health and environmental externalities. The congressmen cited over fifty cases of oil and gas operators commencing operations prior to legal approval to drill. Furthermore,

> [t]here were 2,025 safety and drilling violations issued to 335 companies in 17 states between February 1998 and February 2011. One-fourth of the violations were deemed 'major environmental or safety violations' . . . [and] one-third of a random sample of wells chosen by Interior were hydraulically fractured near, in or below an underground

179. *See* Framework Convention on Climate Change, Report of the Conference of the Parties, 17th Sess. at 2, U.N. Doc. FCCC/CP/2011/9/Add.1 (Dec. 11, 2011) ("*The Conference of the Parties* [to the UNFCCC] *Decides* that the Ad Hoc Working Group on the Durban Platform for Enhanced Action shall complete its work as early as possible but no later than 2015 in order to adopt this protocol, another legal instrument or agreed outcome with legal force at the twenty-first session of the Conference of the Parties and for it to come into effect and be implemented from 2020.").

> source of drinking water. The committee defined 'near' as within a quarter-mile of an aquifer.[180]

Enhanced and integrated governance innovation and technical unconventional natural gas innovation can help incentivize best practices where unconventional natural gas extraction is sensible.

Building on the change-agent role that the World Bank has provided in coordinating technological, legal, and industry initiatives to vent and then capture rather than flare natural gas, I argue that best practices can be shared and built upon to mitigate methane's intense, short-term climate-forcing impact at a time when scientists indicate that we have surpassed the climate tipping point.

This Article analyzes the climate mitigation momentum challenge in the face of uncertainty. It is not enough to say that there is insufficient data on natural gas development and greenhouse gas emissions. State and non-state coordination can gather the information with which to make informed decisions on energy policy. When the oversight role to internalize negative externalities (flaring, for example) atrophies for lack of incentive to balance environmental, health, and economic factors, then decision making should be expanded to levels where balancing is more likely to occur. In some contexts this may be where local health impacts are sufficiently concentrated to galvanize public-private coordination to solve pollution problems. At other times it may be deciding at a level that encompasses both the positive benefit of the natural extraction as well as including those negatively impacted by the production in decision making on such factors as flaring.

Despite broad scientific consensus that climate change is occurring, solution generation has been hampered by the lack of comprehensive life-cycle analysis across energy options. This Article seeks to contribute to the understudied area of climate-energy policy with regard to natural gas development. Hydraulic fracturing has received a great deal of attention since 2008, largely with regard to water implications of natural gas development. Having analyzed this elsewhere, here I seek to build on this ongoing discussion with the key

180. Phil Taylor, *Fines for Violations Rare on Public Lands—Democratic Report*, EENews Greenwire (Feb. 9, 2012), http://www.eenews.net/Greenwire/rss/2012/02/09/5; *see also Noble Energy Brings Large-scale Fracking Plans to Nev.*, EENews Energywire (Jan. 10, 2013), http://www.eenews.net/energywire/rss/2013/01/10/10 ("Noble Energy is awaiting approval for its proposed project, which could produce about 50,000 gallons of oil per day by late 2014. . . . Noble Energy's large-scale proposal could test regulators unaccustomed to dealing with projects of such scope."); Complaint, Ctr. for Biological Diversity v. Bureau of Land Mgmt., No. 11-CV-6174 (N.D. Cal. Dec. 8, 2011) (several environmental groups filed a lawsuit challenging the federal government's leasing of nearly 2,600 acres of federal land in California to oil and gas developers for natural gas development).

challenge of optimizing energy use and mitigating climate change. Ignoring the need for further empirical data and collective decision making should give way to coordinated information gathering and climate-energy solution generation.

For green technologies to play a meaningful role in greenhouse gas mitigation, state and non-state actors at all levels need to cooperate to not only map cradle to grave (life cycle analysis) but also implement robust rather than minimal green technologies. Green technology innovation (both governance and technical) can best be carried out through dynamic federalism, networked from local energy siting challenges to global economic, social, and environmental synergies.

"Who decides" often becomes a legal question of preemption but arguably should involve capacity coordination. That is to say, the states retain powers not exerted by the federal government and not delegated to substate actors. A robust body of literature has examined environmental federalism. I seek to contribute a reconceptualization that broadens the frame of unconventional natural gas analysis to include international, regional (both supra and subnational), national, state, substate, tribal, and non-state actor impacts. Who can exert the power is only one way of looking at the challenge to address unconventional natural gas extraction. Who can best contribute what part of public private partnership coordination to my mind offers a break-out, solution-generating frame with which to bridge economic, social, and environmental synergies. What does this look like? Drilling down figuratively and literally has proved challenging in a vacuum of natural gas information. That said, it is fair to say that substrates vary not only from state to state, but from drilling site to drilling site. Local information can best be gathered through local participant observers in this hydraulic fracturing health, environmental, economic experiment that has ramped up since 2008.

Climate impacts are global while other health and environmental impacts can be quite localized to well-drilling sites. This reality has fueled the confusion over what level of governance should take a lead role in deciding not only the scale of natural gas regulation but also whether to allow unconventional natural gas extraction in the first place.

While a small town may not have the resources to regulate natural gas extraction (an argument being made for decision making to occur at the national or state level), a small town does not need to be rich to be able to decide to ban natural gas drilling.[181] This is not just a capacity issue—it is a more nuanced issue of balancing energy,

181. *Cf.* Gayathri Vaidyanathan, *"We Look to the States' to Implement Federal Rules, Scientists Say*, EENEWS (Jan. 30, 2013), http://www.eenews.net/energywire/rss/2013/01/30/7 ("'I don't see any way an Appalachian county can effectively regulate Marcellus development,' said Paul Roberts, a resident of Maryland's Garrett County who is part of the Maryland Governor's Commission on Natural Gas Drilling.").

social, and environmental cost and benefit sharing.

In contrast, small towns have no greater ability to define diesel fuel than the EPA, given that it was left undefined by the Energy Policy Act of 2005. If the EPA defines diesel based on hydrocarbon molecules found in diesel, then other oils might be included in addition to diesel. While the Energy Policy Act of 2005 created a hydraulic fracturing carve out from Safe Drinking Water Act regulation, this exemption did not extend to diesel fuel use in hydraulic fracturing.[182] Whether trying to define diesel or to balance intellectual property rights, health, and environmental exposure information, to my mind the patchwork of measures curbing unconventional natural gas is anemic.

By coordinating citizen-monitoring groups with academic expertise and public sector environmental agencies, we can pool data, interpret findings, and facilitate life cycle analysis, energy access, efficiency, and climate mitigation. In the abstract these are all shared goals, but the squabbling intensifies as economic, social, and environmental trade-offs are made—particularly when done behind closed doors.

In order to follow through on U.S. commitments under the framework climate convention, the United States should regulate all six principal greenhouse gas emissions, considering their relative lifespans and global warming potential. With regard to methane, strict regulations need to be enforced to prohibit flaring natural gas. Industry flaring, venting, and release of natural gas have substantial climate destabilizing consequences.[183] Less clear are the rates of flaring and the projected leakage rates for natural gas production and transport. Yet, these numbers matter when trying to assess the relative impacts of natural gas *vis-à-vis* coal, oil, nuclear, and renewable cradle-to-grave impacts.

This Article has considered how to move beyond an "either/or" federalism debate to a cooperative governance framework. Dynamic climate and natural gas governance can help gather information, identify climate-energy-water synergies and implement greenhouse gas emissions reductions.

---

182. *See* EPA, Permitting Guidance for Oil and Gas Hydraulic Fracturing Activities Using Diesel Fuels: EPA Discussions with Stakeholders (2011) (including a list of possible diesel fuel definitions); Alan Kovski, *Four Senators Urge EPA to Use Caution In Regulation of Some Hydraulic Fracturing,* Bloomberg BNA (Dec. 22, 2011), http://news.bna.com/deln/DELNWB/split_display.adp?fedfid=23904049&vname=dennotallissues&fn=23904049&jd=a0d0b1g6k4&split=0 (noting the concern of an overly broad definition of diesel fuel).

183. *See* Anna Driver & Bruce Nichols, *Shale Oil Boom Sends Waste Gas Burn-Off Soaring*, Reuters (July 25, 2011, 2:18 PM), http://www.reuters.com/article/2011/07/25/us-shale-flaring-idUSTRE76O4SU20110725 (noting that flaring of natural gas substantially adds to global warming).

SCHOOL OF LAW
CASE WESTERN RESERVE
UNIVERSITY