DUKE ENVIRONMENTAL LAW & POLICY FORUM SYMPOSIUM 2012

ENVIRONMENTAL AND SOCIAL IMPLICATIONS OF HYDRAULIC FRACTURING AND GAS DRILLING IN THE UNITED STATES: AN INTEGRATIVE WORKSHOP FOR THE EVALUATION OF THE STATE OF SCIENCE AND POLICY

WORKSHOP REPORT[1]

INTRODUCTION

Advances in drilling technologies and production strategies such as horizontal drilling and hydraulic fracturing now allow natural gas developers to access previously untouched geologic formations containing natural gas. These new technologies have significantly increased natural gas production by stimulating the flow of gas from low-permeability formations. The ability to access new reserves of natural gas in the United States has spurred hydraulic fracturing in western states like Colorado and Wyoming, throughout the Midwest in Texas and Oklahoma, across the East in Pennsylvania and New York, and as far south as Arkansas and Alabama.

Hydraulic fracturing has accelerated the production of natural gas, dramatically changing the energy landscape in the United States. Some estimates predict that the reserves of natural gas now available through hydraulic fracturing could supply energy to the United States for nearly a century. Some regions of the United States never before home to large-scale oil or gas production have become drilling epicenters, and production surges across the United States have contributed to historically low natural gas prices.

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1. This report was prepared by David S. Steele and Jennifer M. Hayes (Duke Environmental Law & Policy Forum, Volume XXII), Erika Weinthal, Robert Jackson, and Avner Vengosh (Nicholas School of the Environment at Duke University). It does not reflect a consensus document from the participants of the meeting. David S. Steele and Jennifer M. Hayes are 2012 graduates of Duke Law School.

Some view the ability to access reserves of untapped natural gas in shale as a means to increase domestic energy independence, as a cleaner and economically viable alternative to coal, and as an opportunity to boost a struggling U.S. economy. Others question these claims by pointing to new research highlighting the environmental, economic, and social consequences that may accompany natural gas extraction through hydraulic fracturing. Many are concerned that hydraulic fracturing is not worth the environmental and other social costs, while others insist that if done properly, hydraulic fracturing can be a safe and sustainable way to provide clean energy.

In 2011, the National Science Foundation provided a grant to professors Avner Vengosh, Robert Jackson, and Erika Weinthal from the Nicholas School of the Environment at Duke University (EAR, Division of Earth Sciences, Emerging topics #1137904 *Environmental and Social Implications of Hydraulic Fracturing and Gas Drilling in the United States: An Integrative Science and Policy Workshop*, 08/15/2011–08/14/2012) to conduct a workshop on the environmental and social implications of hydraulic fracturing and gas drilling in the United States. With additional support from the Nicholas School of Environment at Duke University, Duke's Center on Global Change, and the Duke Environmental Law & Policy Forum from Duke Law School, on January 9–10, 2012, Duke University brought together hydraulic fracturing experts from industry, science, academia, law, federal agencies, regulators, and the environmental sector, to address the scientific, economic, environmental, legal, and socio-economic effects of hydraulic fracturing or shale gas drilling in the United States.

Entitled: *Environmental and Social Implications of Hydraulic Fracturing and Gas Drilling in the United States: An Integrative Workshop for the Evaluation of the State of Science and Policy*, the purpose of the workshop was threefold: (1) to provide a forum for meaningful dialogue between experts on the various issues involving hydraulic fracturing; (2) to provide the public with an opportunity to learn more about hydraulic fracturing from recognized experts; and (3) to advance the academic, scientific, and legal discourse surrounding hydraulic fracturing by compiling a report summarizing the information shared and gained at the workshop.

Organizers accomplished these objectives by dividing the event into two days. To facilitate public involvement, the first part of the workshop was an open public session. Over 400 guests from across

the United States attended the session. The public session was also streamed online where more than 2000 unique viewers observed the workshop live.[2] In addition, students posted real-time updates from a Twitter account on topics discussed during the workshop.[3] The public session was held in a large auditorium at Duke University and speakers discussed shale gas development and hydraulic fracturing in three panels: (1) *An Overview on Shale Gas Development*, (2) *Major Scientific Results*, and (3) the *Legal and Socio-Economic Setting*. The first panel included an overview of energy outlook and trends, a presentation by the U.S. Environmental Protection Agency discussing their upcoming study on hydraulic fracturing, and a presentation on leakage concerns in the natural gas supply chain and how releases of methane from hydraulic fracturing could impact global warming. The second panel provided a summary of major scientific findings regarding potential water contamination from shale gas production, the possible greenhouse gas footprint of shale gas, and the management of hydraulic fracturing wastewater. The third panel characterized hydraulic fracturing's economic and sociological impacts and closed with a discussion of the appropriate methods to compare state regulations of shale gas production.[4] At the conclusion of each panel, members of the public asked the speakers questions, including electronicly submitted questions from online viewers.

The second part of the workshop was comprised of closed-door sessions with invited speakers and participants. The objective of these sessions was to discuss in greater depth the more technical, legal, socioeconomic, environmental, and regulatory issues surrounding hydraulic fracturing. Throughout the non-public session, speakers presented on various topics, and participants asked questions in a roundtable-like atmosphere. The sessions included: (1) *Stray Gas: Sources and Pathways*, (2) *Tracing the Sources of Fracking Waters and Stray Gas*, (3) *Fracking and Produced Water: Regional Studies and Management*, (4) *Community Issues*, and (5) *Regulatory Issues.* The closed format of the second part of the workshop was specifically designed to encourage participants to speak freely without the pressures and spotlight of a public audience.

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2. The video feed of the first day is available at: http://www.nicholas.duke.edu/hydrofrackingworkshop2012/video (last visited May 15, 2012).

3. The Twitter page is available at: http://twitter.com/ShaleGasWkshp (last visited May 15, 2012).

4. The list of speakers and agenda are available on the conference website site at: http://www.nicholas.duke.edu/hydrofrackingworkshop2012/agenda (last visited May 21, 2012).

Finally, the goal of this workshop report is to advance the academic, scientific, and legal discourse surrounding hydraulic fracturing. To foster free discussion during the workshop, speakers and participants agreed to not attribute any of the information discussed in this report to a specific speaker, participant, or organization. Rather, this report captures the authors' views of the major themes, issues, topics, trends of discussion, and proposals offered by participants. This summary is not a consensus document nor is it meant to represent the view of all participants. It should assist those not at the workshop to better understand the issues surrounding hydraulic fracturing and some of the conversations that took place during the workshop.

We have divided the main themes and topics explored during both days of the workshop into five categories: Energy System Overview, Information Gaps, Outreach and Communication, and Law and Regulation. Below we explore each of these subjects and discuss the role each played during the workshop.

I. ENERGY SYSTEM OVERVIEW

Like decisions about all energy sources, discussion of hydraulic fracturing technology and the use of the resulting shale gas cannot take place in a vacuum. While workshop participants focused their attention on shale gas, they also referenced the many variables and components that combine to form the global energy system. All participants agreed that global demand for energy would continue to rise. This consensus led participants to suggest that the use of natural gas must be evaluated alongside other energy sources, geopolitics, existing energy infrastructure, opportunity costs, climate impacts, socio-economic realities, and environmental degradation. While not all participants agreed on how to properly understand and prioritize these and other considerations, several themes did emerge.

Rising Energy Demand. Generally, participants agreed with U.S. government and industry analyses that global energy demand will continue to rise in the next thirty years even if countries like the United States implement significant energy efficiency measures. Participants agreed that increasing global population and standards of living are drivers of predicted demand. Regardless of the availability of other sources of energy, many participants believe that shale gas is likely to be an important resource in meeting current and increasing electricity and transportation demands across the globe.

Viability of Natural Gas as a Transition Fuel. The role of natural gas in meeting energy demand was an important consideration for participants. Some viewed natural gas as a transition fuel between coal and renewables, while others expressed concern that investing in infrastructure to accommodate increased natural gas development would lock nations into natural gas dependence for decades. With an eye toward global markets, participants suggested that shale gas could significantly foster European energy independence from Russia, since Europe has long been dependent on Russia for natural gas. As European nations grow more skeptical of nuclear energy, alternative natural gas supplies become especially important. While a number of participants expressed concern that natural gas development could come at the expense of development of renewables, participants agreed that natural gas would likely be an important source for electricity generation in the United States and elsewhere for years to come.

Greenhouse Gas Lifecycle Analysis. Speakers emphasized that shale gas should be evaluated for greenhouse gas emissions at each stage in its production and use lifecycle. Some speakers argued that fugitive natural gas leaks that occur at the wellhead and other places during distribution might accelerate climate change because natural gas is composed of mostly methane, a potent greenhouse gas. While speakers disagreed on the actual estimates of fugitive gas emissions, experts agreed that if fugitive gas emissions were significant enough, the leaks could, in principle, diminish any advantage natural gas might have over other fossil fuels in reducing greenhouse gas emissions. However, many participants did not believe that sufficient evidence existed to confirm that suggestion.

Relative Impacts. In addition to needing a better understating of the greenhouse gas emissions attributable to increased shale gas development, participants emphasized the need to understand the impacts of choosing natural gas over alternative fuel options. This discussion included not just relative greenhouse gas emissions between energy sources, but improvements in air quality compared to coal-fired electricity generation, such as reduced emissions of mercury, particulates, and other pollutants, as well as relative impacts on community and regional development globally. Some participants emphasized that natural gas impacts on the environment, communities, and the economy should be made in the context of both "cleaner" and "dirtier" alternatives.

Environmental. As with all discussions of energy resource development, environmental concerns captured the attention of participants. Environmental concerns included water pollution, air pollution, landscape effects, habitat loss, and potential human health effects. Concerns about potential drinking water contamination from both thermogenic methane and produced or flowback waters were coupled with lengthy discussion about appropriate contamination detection and geochemical analysis methods. All participants identified wastewater management as extremely important in preventing ecological harm. Discussion on environmental impacts also detailed current efforts across government agencies to better understand shale gas development.

Social and Economic Impacts. Some participants emphasized the expected economic and social impacts that accompany energy resource development. The benefits of reducing reliance on foreign oil and using domestic energy sources was commonly expressed. Most participants agreed that shale development creates jobs and at least a temporary boom in regional economies. Less consensus existed in how extensive the long-term economic impacts of shale development on regional communities are. While some participants projected long-term financial gains, others noted that social science research has observed boom-and-bust economic cycles associated with regional resource development. Related to economic concerns were social concerns about degradation of community identity, cultural resources, and self-determination. Some participants urged careful consideration of communities' access to information pertinent to hydraulic fracturing, mechanisms for decision-making, and regulatory oversight.

Tradeoffs and Practical Policy. Each energy source available to the global economy has benefits and costs. Throughout the discussion on energy systems, participants continually discussed balancing the relative tradeoffs of energy source development. Despite different weighing of the relative benefits and costs, most participants agreed on the need to develop practical policies that will provide workable solutions that mitigate any ecological, human health, and social harms, while maximizing economic and energy returns.

II. INFORMATION GAPS

During the course of the workshop, much of the debate surrounding hydraulic fracturing centered on the need for more information. The combination of extensive horizontal drilling and

high-pressure hydraulic fracturing technologies is a recent development for energy production in the United States, and many critical questions surrounding its processes and effects remain. Some of these questions include: How much natural gas and other hydrocarbons actually exist in the United States that energy producers can access through horizontal drilling and hydraulic fracturing? What are the actual environmental effects of hydraulic fracturing, including potential air and water pollution? Does hydraulic fracturing contaminate drinking water, and if so how? What are the socio-economic impacts associated with hydraulic fracturing? What are homeowners' rights upon signing a lease to drill on their property? How can state governments best regulate hydraulic fracturing, and how should the federal government be involved?

Although this list is not exhaustive, these kinds of questions generated significant interest and discussion among participants. Many participants indicated that more information is needed before some of the questions noted above can be fully answered. The need for more information on hydraulic fracturing led to the following themes and conclusions:

The Important Role of Science. Many participants pointed to the need for more scientific research. Although considerable research is underway on hydraulic fracturing by academic institutions, state and local governments, the federal government, energy companies, and private research firms, participants acknowledged that more research is needed to better understand the full implications of hydraulic fracturing. Some participants observed how few peer-reviewed publications there are on hydraulic fracturing and emphasized that, while considerable data are generated by companies, much of the data is unavailable publicly (for diverse reasons).

Despite data needs, experts at the workshop were able to present some helpful information based on their own scientific research. For instance, presentations discussed uncertainties for releases of methane into the atmosphere associated with natural gas extraction and distribution; potential contamination of drinking water near drilling sites; the use of isotopic tracers to track hydraulic-fracturing and produced-water fluids; and sociological studies examining quantitative social impacts of hydraulic fracturing.

The Need for Funding and Credible Science. Many participants called for additional funding for hydraulic fracturing research. Participants also acknowledged that funding sources raised important questions about funding bias, either real or perceived. Hydraulic

fracturing research, in particular, has been heavily criticized as being tainted by third-party funding. Some participants lamented the difficulty of locating funding from credible sources without the risk of funding compromising their research. Others argued that federal funding could resolve some of these issues.

Despite the funding concerns, participants continued to underscore the need for collaborative research that is credible and unbiased. Credible and well-supported research will provide concrete information that can be relied on and trusted by stakeholders. Emphasis was given to disseminating information through publication in peer-reviewed journals.

III. OUTREACH AND COMMUNICATION

During the private session of the workshop, there was significant discussion about how to provide the public and government regulators with useful information on shale-gas extraction. The court of public opinion is often the forum where policy decisions, such as whether to legalize or how to regulate hydraulic fracturing, are influenced. How to help the public better understand horizontal drilling and hydraulic fracturing as to be able to effectively evaluate shale-gas extraction dominated participant discussion.

During one of the sessions, participants discussed how to connect information gained through scientific research to the public. One speaker observed that a significant communication barrier between science and the public is that public response to hydraulic fracturing is contentious. The speaker suggested if the public is given the right information about hydraulic fracturing, they are more likely to make sound decisions. A challenge, however, is to provide information in a way that precludes people from selecting only the scientific facts that support their position. Participants discussed the possibility of education campaigns and public outreach to better communicate scientific information to the public.

The need to communicate critical information does not necessarily inform which method of communication is most effective. Because it was unclear to participants where the public is obtaining scientific information on hydraulic fracturing and whether that information is accurate, questions arose as to the capacity of journalists to communicate complex, scientific information. Some suggested that scientists should communicate directly with the public by publishing digestible reports. Others stated that media reports, bloggers, and other alternative mediums of communication might

have a greater influence on the public than scientific reports. Some participants expressed concern that scientific information presented on social network websites and blogs hurts the credibility of the information; others disagreed, indicating the social media may now be the most effective way to communicate information. Either way, participants generally agreed that complex scientific and social policy issues, such as hydraulic fracturing, needs to be communicated as clearly as possible using diverse outlets.

IV. LAW AND REGULATION

Regulation of hydraulic fracturing and related shale gas production and transportation activities take place privately, locally, and at the state and federal levels. Regulation occurs through a patchwork of industry initiatives, local ordinances, state legislation, and federal environmental laws. For example, the Federal Energy Regulatory Commission regulates siting and construction of interstate natural gas pipelines, but the Department of Transportation regulates pipeline safety. For pipelines contained within a single state, state public utility commissions or equivalent state agencies can regulate pipeline construction and safety. Workshop participants continually referenced the federal-state-industry patchwork regulatory system with both praise and criticism.

Federalism. Participants had different views on the role of federal regulation in an industry regulated first and foremost by states. Those in favor of state regulation emphasized that state regulators better understand the unique social, hydrologic, and geologic characteristics of their shale basins. They believe that state regulations best balance the economic and environmental benefits and risks of hydraulic fracturing. Others in favor of a stronger, federal regulatory scheme advocate for the use of cooperative federalism. Under this framework, the federal government sets a regulatory floor on water and air protections. States have generally been left to regulate resource extraction, water use, and land planning, while the federal government has only intervened to protect interstate commerce and national resources. Some participants believe that the current federal environmental laws with a few minor modifications could be sufficient to address shale gas production processes that impact air, water, and land resources. Others advocated fundamental reform of environmental laws.

State Regulation. Each natural gas producing state has a varied regulatory regime. Focusing just on the royalty tax structure, for

example, some participants questioned how states were distributing hydraulic fracturing royalty proceeds among producing and nonproducing communities. Some participants feared that states accrue most of the benefits from taxation, while local communities bear the burden of resource production. Others voiced concerns about upstream shale gas producing communities retaining most of the tax benefits from fracturing, but downstream communities without shale resources suffering some negative effects. Participants also discussed variation in protection of water resources by comparing regulatory systems in Pennsylvania and New York. The intricacies of contract and tort law were particularly relevant and interesting to participants. As contract and tort law vary by state, some participants wondered if each state has the institutional capacity necessary to ensure fair outcomes between companies and individuals.

Local Regulation. Further complicating the discussion of public regulation of shale gas production is the ability of local governments to institute ordinances and zoning regulations aimed at curbing shale gas production. A few participants argued that the use of bans at the local level is an appropriate attempt to act according to the precautionary principle in response to public preferences. The precautionary principle places the burden of proof to demonstrate the safety of an action on the party that seeks to take that potentially harmful action. Other participants emphasized that effective regulation could only be established if companies faced uniform standards and rules across a state. Variation in states being "home rule" or "Dillon's rule" further complicates the discussion of the role of local regulation. While a local regulation may be responsive to local sentiments, municipalities in states adhering to Dillon's rule may lack authority to regulate shale gas production.

Private Regulation. The role of private regulation of shale gas production elicited substantial discussion among participants. Participants debated the effectiveness and legitimacy of industry-sponsored regulation. An example of one industry initiative discussed is the FracFocus.com chemical disclosures. For most participants it was an example of industry responding to citizen concerns and an affirmation of industry initiatives. Other participants argued that these disclosures were an improvement but incomplete.

Regulatory Collaboration. Related to the conversation about industry initiatives was the process by which public regulators should attempt to solve problems. Some participants advocated that

regulators should first attempt to work directly with industry to solve problems, to avoid politicizing an issue that might better be solved by direct regulator–industry cooperation. Concerns were expressed for obtaining greater public input for determining acceptable tradeoffs and risk to human health and the environment.

Role of Courts. Some individuals have turned to the courts to address grievances. Disputes arising from shale gas production include both pre-drilling and drilling issues. In the arena of pre-drilling, concerns about contracts have dominated, including suggestions of predatory leases and deceptive tactics to convince landowners to sign unfavorable drilling leases. Leasing issues discussed included the validity and duration of lease agreements, fraudulent inducements to execute gas leases, and enforcement of arbitration clauses in lease agreements. Lawsuits related to the drilling process sometimes take the form of nuisance claims. An area of particular interest to participants was the legal concept of "causation" and its relation to scientific causal determinations.

CONCLUSION

The spectrum of opinions surrounding hydraulic fracturing has, in some cases, fostered conflict and disagreement between energy companies, scientists, economists, environmentalists, landowners, and government officials. Despite this divergence, the workshop successfully generated a greater understanding and appreciation for different viewpoints. Participants emphasized the need for more collaboration among stakeholders, particularly cooperation between the private and public sectors. The state of North Carolina provides a prime example. North Carolina currently has no oil and gas extraction, and horizontal drilling and fluid injection are illegal. If the processes are legalized, the state presents an opportunity for scientists to work with government and industry to better understand horizontal drilling and hydraulic fracturing, and to adapt regulation to reflect this improved understanding.