Responding to Technical, Environmental, and Regulatory Impacts of North American Shale Development



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The Aspen Institute
Energy & Environment Program

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2014 Aspen Institute Modern Shale Gas and Oil Production Forum

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Foreword

The first annual Aspen Institute Modern Shale Gas and Oil Production Forum was convened in Aspen, Colorado, July 20-23, 2014, to examine the ongoing shale gas and oil boom and discuss the strategies being adopted at the state level to deal with its impacts. The Forum brought together a diverse group of experts, including state regulators and representatives from industry and the environmental community. This report summarizes those discussions.

The pace of change in US oil and gas production from shale over the last several years has been truly astounding. What started as an effort by a few leaders of small independent companies to wring profits from what were thought at the time by most experts to be "mature" fields has very quickly evolved into an international force that is driving fundamental changes in global energy markets. The economic benefits of this apparent boom seem clear to many, but there have been other impacts – technical, environmental, and regulatory – that can and must be addressed for the economic benefits to be sustained and other benefits to be fully realized. Even in just the time between this forum (July 2014) and the publication of this report (February 2015), oil prices have changed dramatically and the Environmental Protection Agency (EPA) has announced plans to propose new rules regulating methane from new and modified oil and gas operations.

The overarching purpose for convening this Forum was to create a neutral venue for substantive discussion, given the polarization

and paralysis that exists elsewhere. Perhaps the key outcome of this Forum is the creation of a new level of trust between representatives from the environmental, scientific, regulatory, and corporate communities.

We wish to thank all the participants who joined the conversation. Their expertise and candor enabled new, collaborative, cross-disciplinary thinking. The opportunity for state regulators to take part and meet with each other along with experts and stakeholders from across the country created an invaluable space for sharing ideas, best practices, and lessons learned. We look forward to building on this foundation when we convene again next summer.

We thank our rapporteur Dave Grossman for ably capturing the major points of the discussion in this eminently readable report. Tim Olson and Nikki DeVignes managed the preparation details, and we are thankful for their conscientious dedication.

We are particularly grateful to the Rodel Foundation, the Cynthia and George Mitchell Foundation, and JPMorgan Chase for sponsoring this Forum.

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Executive Summary

The shale oil and gas boom in the United States is reshaping the domestic and global energy landscapes. The US shale revolution happened relatively quickly, rendering obsolete the projections of US oil and gas imports from just a few years ago. Growth in gas production has been led by the Marcellus Shale, while growth in oil production has been led by tight oil from the Eagle Ford, Bakken, and Permian. The shale boom has had a greater positive impact on the US economy than the 2009 stimulus, caused modest job growth, altered global gas markets (which has geostrategic implications), and has arguably spurred reductions in carbon dioxide emissions from power plants. It has also aroused concerns about a range of environmental and community effects, including water use and availability, surface and groundwater contamination, air emissions, land use impacts, induced seismicity, and local nuisance issues.

Shale oil and gas activities are regulated primarily at the state level, though local governments have become increasingly relevant as they pursue controversial efforts to place bans or moratoria on shale development within their jurisdictions. The federal government, too, has a suite of regulations, proposed regulations, studies, and debates that affect shale development and the use of shale oil and gas. The industry is changing so fast that regulators at all levels have had to react very quickly to modernize their regulatory regimes, often without the benefit of good data. States have been taking the lead in trying to respond to changing conditions by rededicating themselves

to a process of continuous regulatory improvement and identifying other states' good practices they can modify and adapt. States are pursuing a range of measures, including developing a state oil and gas regulatory exchange, requiring public disclosure of hydraulic fracturing chemicals, and revising internal regulatory processes and rules to facilitate engagement by a wider range of stakeholders.

Federal agencies, meanwhile, are serving as advisors and sources of information and are helping to level the playing field by ensuring implementation of the best practices that states and industry have already developed. Leading companies are taking action too, going above and beyond regulations with forward-thinking programs and practices.

Among the targets for regulatory action and best practices are the air pollutant emissions from shale oil and gas production. Government agencies are measuring, monitoring, and conducting basic research to better understand the industry's air quality impacts, engaging in cooperative and voluntary efforts with state governments and various stakeholders, and issuing regulations and air quality standards. Leading companies are taking steps to address air quality impacts as well, such as expanding the use of natural gas instead of diesel to generate power for drilling rigs and well completion.

Shale production is also a source of methane emissions – a potent short-term climate forcer – which has ignited a debate about whether shale gas is actually a benefit for the climate or not. There is very little data available regarding methane emissions from shale production, and estimates of the leak loss rate vary widely. Still, even as studies have continued, conversations have started shifting from whether there is a need to reduce methane emissions to how to do it. Policy action on methane is beginning at the state and federal levels, including potential rulemakings on methane reduction, leak detection and repair, and green completions. There are industry efforts underway to find solutions to the methane issue too, including research collaborations, leak detection and repair programs, and voluntary commitments to reduce the leak loss rate below 1% across the natural gas value chain.

While air pollution and methane emissions are already high on the policy agenda, the impacts of shale production on water and land are rising in prominence. States and commissions, especially in places experiencing droughts, are trying to better understand the water resource needs and impacts (both at the surface and below ground) from shale oil and gas production, which is made harder due to a general lack of reporting requirements on the source of the water used for hydraulic fracturing. Leading companies have been figuring out how to use less water in fracking and reduce the amount of wastewater going into injection wells, such as by recycling more water. Many others in the industry, though, are not taking action, not sharing data on water practices, and generally not trying to be part of the solution to water quality and quantity concerns.

There are also some movements by states and within industry to greatly reduce the number of trade secret claims when it comes to disclosure of the chemicals in fracking fluid, which is a big issue when it comes to water quality concerns. In addition, the sheer scale of shale development, the massive infrastructure build-out that has already occurred, and the even bigger build-out expected to occur in the years and decades ahead is raising serious concerns about cumulative impacts on land, including increased conversion to impervious surfaces and impacts on soil erosion, drainage, sedimentation, surface hydrology, and species.

This change in the order of magnitude of horizontal drilling and hydraulic fracturing activity, combined with other factors such as increased collisions between industry and communities, has led to an extremely vitriolic, polarized public conversation about shale development. This conversation has been characterized by misinformation, demagoguery, defensiveness, and distrust. In such an environment, there is little serious dialogue, and facts and data tend to get very little traction, but there are efforts underway to try to grow what could be thought of as a radical center of passionate pragmatism. Changing the conversation may require industry to gather and share data, tell a better story about the benefits of the shale revolution, and acknowledge and address the emotional aspects of the debate. The effort to move to a more centered conversation might

also benefit from a longer-term perspective, as modern shale gas will be a key part of the energy economy for decades; this perspective could spur stakeholders to pursue more of a cumulative, watershed-based approach and to try to find actual solutions to the issues shale development raises.

Going forward, there must be continued or greater focus on community impacts, the process of continuous state regulatory improvement, the need for the industry to tell its story better, the need to educate and engage the public, and the need to engage a broader range of voices in discussions (e.g., service companies, financial institutions, royalty owners, small producers, local government officials).

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Dave Grossman
Rapporteur

The Current Shale Landscape

There is an energy boom in the United States, driven by the revolution in shale oil and gas production. This boom is changing the global energy landscape, with impacts on markets, the economy, international affairs, the environment, and communities. The shale revolution is happening within the confines of federal, state, and local regulations.

Market Dynamics

Current global energy markets are in a state of dramatic transformation. New demand growth is coming from outside the developed countries, and energy trade flows have shifted, with the Western Hemisphere getting more isolated and more Middle East crude going to Asia. Among the most notable shifts is that new growth in oil and gas production is coming from outside the Organization of the Petroleum Exporting Countries (OPEC).

Because of the shale revolution, North America plays by far the most important role in the changing oil and gas production story – and that revolution came pretty quickly. In 2005, the US Energy Information Administration (EIA) projected that the United States would be importing 18 bcf/d of natural gas in 2014. The United States is now expected to be a net exporter of natural gas by 2020, with US gas production growth led by the Marcellus Shale; the United States and Australia are also expected to lead significant growth in the global liquefied natural gas (LNG) trade. The story is

similar for oil – while the United States will still be a net importer of oil, the amount of oil that the EIA now projects the country will import in 2025 is 14 million b/d lower than the projection in 2005, due to increases in production and decreases in consumption. Nearly all the growth in US oil production has been from tight oil accessed via hydraulic fracturing, mostly from the Eagle Ford, Bakken, and Permian. All that tight oil is light oil, which is not exactly what the US refinery system was configured to handle, but it has resulted in a significant reduction in imports of light oil (most of which had come from West Africa).

Amidst all this change, there has been remarkable price stability, at least as of July 2014. The price of oil barely moved over the previous 2-3 years, possibly because the US production of about 3 million b/d almost perfectly offset the various global supply disruptions. Still, markets expect oil prices to soften.[1] In addition, US natural gas prices have dropped, and the historic connection between the US natural gas price and the European and Asian prices has now broken apart, which has economic and competitive implications.

Impacts of the Shale Boom

The economic impact of the shale boom in the United States has been significant – and greater than the 2009 stimulus. At a time when the economy is struggling, the oil and gas boom has been one of the most positive factors out there. The jobs impact has been positive too, but by no means a game changer, given that energy employment is small relative to the overall economy.

The boom has had geostrategic benefits as well – such as US supply more than offsetting the oil from Iran lost due to sanctions. The biggest geostrategic impact from the US gas boom has probably been the elimination of the need to import gas into the United States, which means gas has flowed into the global market, creating more diversity of supply and putting downward pressure on prices – including squeezing the margins the Russians can get in the European market.

1 This was the status of oil prices at the time of the forum; as of the time of publication, oil prices have fallen dramatically.

The shale revolution has also had environmental and community impacts. In a time when the impacts of climate change are starting to be felt, shale has spurred an arguable decline in US carbon dioxide emissions, though coal is starting to regain its market share, and there are serious concerns about fugitive methane emissions. Some key environmental and community challenges include water use and availability, air emissions, land use, components of fracturing fluids, produced water management, soil and groundwater contamination, waste disposal, induced seismicity, construction and operation of infrastructure, impacts on species (including migratory birds), impacts on wetlands, and local nuisance issues (e.g., noise, traffic).

Existing Regulatory Structure

There are regulations at multiple levels that affect oil and gas exploration and production.

For the most part, the activity is regulated at the state level. Many of the regulatory issues related to shale oil and gas development are not new (e.g., rules about casing and cementing) and are already in regulatory regimes, but not in ways that the public can really understand and get their hands around, so some states have pulled out those various existing pieces and reassembled them into a new single rule. Comparative analyses of state regulatory efforts tend to show that some do water well, some do air well, some do wellbore integrity well, some do public processes well, etc. – but none do all of them well.

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While states generally take the regulatory lead on shale production, local governments have become increasingly relevant. While only a few states currently have statewide fracking bans or moratoria, some states have localities that have bans or moratoria, the legality of which is being challenged in the courts. Even states with strong rules to address issues from oil and

gas development are encountering attempts at local bans from communities still concerned about hydraulic fracturing. Local governments can also impose zoning and other restrictions on oil and gas development.

The Pennsylvania Supreme Court recently invalidated a state law seeking to restrict the ability of localities to use their zoning authority to limit oil and gas development, relying on a moribund environmental rights amendment to the state constitution. Several states have similar constitutional provisions, and others are seeking to add them. Some courts have ruled that communities can regulate land use in their borders and can ban oil and gas drilling in their jurisdictions but cannot set up specific rules about things like how drilling would be done, though there has not been a lot of clarification of where exactly the line is. There also may not be a consistent story yet from state to state and court to court.

At the federal level, there are a lot of regulations, proposed regulations, studies, and debates that could affect shale development, but it is not clear how coordinated all of these different moving parts are or whether there is a vision for how they all work together.

At the federal level, there are a lot of regulations, proposed regulations, studies, and debates that could affect shale development, including the new source performance standard for new gas wells (the Quad-O rule) from the Environmental Protection Agency (EPA), air emission rules, water use rules, methane studies and emission reduction proposals, the announced rules for carbon dioxide emissions from power plants, the Pipeline and Hazardous Materials Safety Administration's concerns about gathering lines, debates about gas exports, potential rules from the Bureau of Land Management about federal lands, potential regulations related to species protection (e.g., sage grouse), and others. All of these will impact shale production and how natural gas and oil supplies are used, but it is not clear how coordinated all of these different moving parts are or whether there is a vision for how they all work together.

The regulatory challenges faced by industry can vary based on geology, geography, local population, and other issues. In the Marcellus, there are particular challenges with flowback and produced water management, disposal of naturally occurring radioactive materials after wastewater recycling, and pipeline construction and expansion to get gas to market (including questions about whether to look at the cumulative impacts of all oil and gas development in the play or just the impacts of a particular segment of a pipeline). In the Eagle Ford and Permian, the biggest challenges are water supply (especially given local drought conditions) and deep well injection versus water recycling, as well as issues concerning threatened and endangered species. In the Bakken, key challenges include flaring, the characteristics of the crude oil (and rules on rail transport), the lack of infrastructure (both pipelines and social infrastructure such as housing and public services), and the involvement of multiple jurisdictions (including federal, state, and tribal). In the Monterey Shale, which is the largest but also most complex shale play in the United States, the challenges are adequate technology to get the oil out and California's rigid regulatory regime (as well as public perception and opposition in the state).

Regulatory Modernization

The shale revolution is just beginning, and for the most part, it seems that regulators are playing catch-up. State and federal agencies, as well as the industry, have key roles to play in ensuring that the emerging issues associated with shale production are addressed.

States Taking the Lead

Oil and gas regulation is primarily the purview of the states, and states have been working actively through the years to develop appropriate regulatory regimes that address the challenges associated with modern oil and gas production. States have been the laboratories for regulatory development, seeking both to protect the environment and fully produce oil and gas so as not to waste those natural resources. In the 1920s and 1930s, with the rapid growth of oil and gas development, states had to figure out how to protect water, protect air, handle spacing issues, and the like. The current oil and gas boom presents new versions of the same issues, as well as some entirely new ones. The industry is changing so fast that regulators have had to adapt very quickly to address emerging issues and to reassure the public that they are doing their jobs.

States have many avenues they can pursue as they try to modernize their regulatory frameworks to deal with emerging issues around shale development, including changing statutory authority, taking action through administrative rules and regulations, using the latitude available in board hearings, and enacting special field rules

for each new field. Some states, such as California, have required independent scientific assessments of fracking. States can also benefit from participating in national groups of state regulators to learn about best practices.

Geographic and geologic diversity, the dynamism of the industry, and constantly changing technologies, practices, environmental risks, understanding of risks, and options for controlling risks all suggest that there is no single rule or set of rules that would work in all places. The type of shale oil and gas production done and the sorts of regulatory and technological controls needed may be totally different in Pennsylvania, North Dakota, and California, and what worked in Alabama or Texas may be undesirable or unworkable in Utah. Instead, states have been rededicating themselves to a process of continuous improvement, seeking to respond to changing conditions and identifying other states' good practices they can modify and adapt into their own regulatory schemes.

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Effective regulation through continuous improvement is one of the key pillars of States First, an initiative of the Interstate Oil and Gas Compact Commission (IOGCC) and the Groundwater Protection Council (GWPC), endorsed by several governors, that aims to have states take the lead in devising forward-looking solutions. (The other pillars are hydraulic fracturing, underground injection control, state inspector training and certification, and science and technology transfer.) Under the States First initiative, there is an effort to expand the GWPC's existing risk-based data management system (RBDMS) – non-proprietary software that can be adapted to serve each state's regulatory needs with regard to managing and analyzing oil and gas program data and water resources management information – to give the public more information on state oil and gas programs, including on hydraulic fracturing, water, field inspec-

tions, and e-permitting. Most oil and gas producing states are using the RBDMS, which has pretty much every component needed to run a regulatory program. (There will soon be an oil and gas data gateway on the US Energy Information Administration website to streamline access for the public to RBDMS and other state well-level data.) In addition, FracFocus, a national chemical disclosure registry for hydraulic fracturing managed by the GWPC and IOGCC, is being improved to make it more user-friendly for operators and the public, and there will be an interface with the RBDMS so citizens following a permit in RBDMS can also go to FracFocus for data on particular wells. Another States First effort involves development of a State Oil and Gas Regulatory Exchange, overseen by a panel of state regulators, which will bring state policy and technical staff together on a routine and coordinated schedule to share information with each other about common issues in oil and gas producing states. The Exchange will hopefully help foster innovation in the regulatory realm, support continuous improvement in practices and regulation, and facilitate sharing (and comparative analysis) of results with other states.

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State regulators have pursued or are considering a range of regulatory changes to address some of the concerns and issues that have arisen around shale development. For instance, one recent trend in state regulation has been an increased focus on disclosure of the chemicals used in hydraulic fracturing; in 2010, only one state required any kind of public disclosure of hydraulic fracturing chemicals, but now at least 24 states require disclosure (e.g., through FracFocus) or have proposed rules. States are also searching for science-based approaches to manage the risk of induced seismicity (i.e., earthquakes), including trying to get better data and changing regulatory procedures to better assess activities and proposed injection well

applications around earthquake clusters. In addition, some regulators are considering whether there are ways to eliminate the need for well sites to be placed near schools and communities, such as by finding a way around the issue of leases that cannot be crossed between where the horizontal drilling could originate and where the resources are.

Some of the modernization needed by states is more procedural than substantive. For instance, some oil and gas commissions are used to dealing only with companies, but now there are large numbers of other players and stakeholders involved (e.g., environmental groups, communities), and the current internal regulatory processes and rules are not necessarily set up for those types of stakeholders to come in and engage. The importance of creating space for the public to come and participate in rulemakings, informational hearings, and the like cannot be stressed enough. Doing so does not eliminate their concerns, but it helps create a forum for discussion, and what sometimes happens is that the process moves over the course of months from 200 angry people showing up at the start to 10 people who really care and are willing to negotiate. (Of course, sometimes industry and regulators do not want to open dialogues for fear of opening the door to obstructionists, and other times opponents decide not to be part of state dialogues because they believe their voices can carry more weight at the local level in attempts to ban or restrict shale development.)

There is a lot of data that is not available that could help lead to better practices and smarter regulations and help everyone focus on the real problems.

Ideally, in pursuing substantive modernization, state regulatory processes would be informed by scientific and technical information gathered by geoscientists, engineers, and other experts, but data availability appears to be a constant challenge for state regulatory agencies (and, really, for regulators at all levels). There is a lot of data that is not available that could help lead to better practices and

smarter regulations and help everyone focus on the real problems. The oil and gas data that does exist is found in multiple locations and database structures, often with limitations on access (including pay walls). On everything from brackish water to induced seismicity, the data are often owned by private companies that have a right to maintain a competitive edge; industry is paying hundreds of millions of dollars to buy relevant data, so it can be a tricky balance between the data that industry purchases and the data that states and regulators need to create smart policy.

Different entities also hold different information and are not really talking to each other; for example, state environmental regulators often do not have access to the same data that oil and gas regulators do. Government data can be hard to access sometimes too; for instance, until recently, all the well records in California were paper records and thus could not be easily searched. Furthermore, aggregating data across states can be challenging since the definitions of key terms (and even the terms themselves) vary from state to state. There is some hope that data will be better and more accessible in the near future, but regulators and industry must be cognizant of the fact that talking about the need for more and better data can sometimes be heard as an excuse for inaction.

The boom in shale development has also presented a range of other problems for state regulatory agencies. For instance, many of the issues of public concern (e.g., air issues, transportation issues) are beyond the authority of many oil and gas commissions, and while some states bring all their relevant regulators together for regular meetings to discuss the issues they are working on and how best to work together, many states do not have that kind of formal interagency coordination. In addition, at the same time the agencies are getting somewhat overwhelmed by the volume of shale activity that is occurring, they are also having trouble retaining and attracting the people they need to handle that volume. The agencies are competing with the much higher-paying industry for qualified geologists, seismologists, petroleum engineers, and other types of experts, and they are generally losing that competition. Furthermore, demands on state regulators for data have grown astronomically over the past year or two, with people wanting to use data in ways completely

different from what the agencies ever anticipated; meeting all such demands would sometimes require changes to entire information systems and structures, and yet regulatory agencies rarely have the people or money to do that.

Support from the Federal Government

The federal government has a vital role to play in regulatory and policy modernization, though ideally it would fill that role by collaborating with state regulators, the oil and gas industry, and other stakeholders to develop a regulatory plan that makes sense but does not get in the way of the states that are leading. For instance, federal regulations can help level the playing field by ensuring implementation of the best practices that states and industry have already developed. That was the case with the EPA's oil and gas rule, which grew out of a long cooperative relationship with the natural gas industry looking at ways to reduce methane and VOCs, especially during well completion; the EPA found industry had come up with the solution of green completions, but not everyone was implementing that solution, so the federal regulation required it. Beyond leveling the playing field, federal efforts that ensure widespread adoption of best practices and help states fulfill their regulatory obligations (e.g., helping states improve pipeline inspections) can give communities greater confidence and support the industry's social license to operate.

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Federal agencies can also promote modernization by serving as advisors and sources of information. The US Department of Energy (DOE), for instance, helps states and industry understand what the science says about the impacts of development, what

technologies can enable continued improved performance, what meaningful benchmarks would be, and how to convey knowledge in ways the broader public can comprehend. DOE's National Energy Technology Laboratory (NETL) conducts basic research on water use, wastewater disposal, air emissions, seismicity, and other issues to support the need of state and federal regulators to understand the priority concerns. ARPA-E provides funding for technologies that can reduce the impacts of natural gas production on water and air.

The Role of Industry

A robust regulatory regime can give industry credibility with communities, who appreciate having a strong overarching regulatory structure in place. Public trust is the biggest issue facing regulators and the industry, and supporting the enactment of smart regulations is basically effective risk management. However, there are industry approaches to regulatory modernization that will cause – and have caused – blowback, such as trying to shut down the ability of localities and communities to restrict development activity. Unless the industry gets more aggressive about achieving continuous improvement and getting less-well-known members of the industry to embrace that idea, the industry will have a hard time moving forward.

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There is a role for both regulation and best practices in pursuing modernization, and they are related. Regulations tend to be informed by industry best practices (though it may be better to think of them as "today's leading practices" instead of "best practices", as the latter makes them sound finished, whereas the former suggests continuous improvement). There is also competitive advantage for companies in enhancing their social license to operate by going above and beyond regulations. Companies can use forward-thinking programs and leading practices, and that is slowly but surely starting to

happen. The American Petroleum Institute, for instance, is beginning to issue recommended practices that are worth some attention. In addition, some NGOs and companies are coming together in Pennsylvania to roll out a self-governance process through the Coalition for Sustainable Shale Gas Development, developing Top Runner standards and certifications for performance on issues such as air emissions and water protection.

Air Quality And Methane

Among the targets for regulatory action and best practices are the air pollutant emissions (e.g., VOCs, benzene, NOx) from shale oil and gas production. Public concern about these emissions is growing, especially in regions that have experienced rapid development of shale resources. Shale production is also a source of methane emissions, which has ignited a debate about whether it is actually a benefit for the climate or not.

Air Quality

While shale gas replacing coal in power plants can be a significant benefit in terms of cleaning up the air, public concerns about air emissions from shale production and the potential impacts on public health are tough issues to address. Regulators cannot definitively say that communities are not being adversely impacted by the wells next door, even if they think adverse impacts are unlikely. Some health risk studies have been done identifying the levels of various air pollutants at certain distances from well sites, including at different altitudes (due to sensor data all the way from ground level to satellites), but while these types of studies can clarify what is in the ambient air and what is coming off of well sites, they cannot illuminate what anyone's personal-space air quality is or the source of pollutants in that space, as there are so many confounding factors in exposure. The studies also take a long time, much to the chagrin of legislators and the public, who want faster answers.

Although unable to provide definitive answers, government agencies do play a range of vital roles in understanding and addressing the industry's air quality impacts. For instance, they are essential players in measuring, monitoring, and basic research; a lot of what is known about air quality is because of the EPA's thousands of ambient air quality monitors across the country and the NASA satellites that aid in air quality studies. Federal agencies also engage in cooperative and voluntary efforts with state governments and various stakeholders, such as the EPA's Natural Gas STAR program, the EPA's workshops to evaluate mobile/handheld air quality monitors, and a range of DOE initiatives. Another key role involves offering incentives and funding to governments and stakeholders for identifying and reducing air quality risks. And, of course, agencies also issue regulations and set air quality standards, such as the Clean Air Act programs that states implement and the EPA's Quad-O rules on hazardous ambient pollutants from new sources in the oil and gas sector (though some consider it a glaring gap in EPA's Quad-O new source performance standard that it only applies to gas wells but not oil wells, many of which also produce significant amounts of methane).

There are actions industry can take – and that progressive operators are already taking – to address air quality impacts as well, such as improving management of water and fluids in the field (which are moved by truck) to reduce the amount of truck traffic, expanding the use of natural gas instead of diesel to generate power for drilling rigs and well completion, consolidating well locations, and pursuing electrification. On the other hand, there may be tradeoffs or limitations that have to be considered for some of those approaches. For instance, electrification may or may not help air quality depending on what the fuel source is for the electricity and where the power plant is located (though some are also starting to test a distributed generation approach, burning their own produced gas on-site). Electrification also links the fuel production and delivery systems to the electrical system, and those interdependencies could undermine the resilience of the gas system in the face of natural disasters (i.e., if the power goes out). Well consolidation may also be problematic in non-attainment areas, as consolidation could create a major source that may not have any offsets.

Methane

Carbon dioxide is the most important greenhouse gas in terms of long-term climate impacts, and natural gas, when used to create electricity, produces much fewer carbon dioxide emissions than coal. Fuel switching from coal to natural gas has therefore been a major focus of climate efforts. Natural gas, however, is mostly methane, which decays quickly in the atmosphere but is a very potent greenhouse gas. Much of the warming being experienced today results from short-term climate forcers, and methane is the largest of those. Though methane emissions also result from other sources, such as livestock and agricultural practices and from the decay of organic waste in municipal solid waste landfills, oil and gas development is America's largest industrial source of methane. Significant methane leakage along the natural gas value chain and from oil wells could call into question the net impact of gas on the climate. Given that natural gas will likely be relied upon for decades, it is essential to continue to build on progress in reducing methane emissions and make gas part of the climate solution (though even if produced responsibly, natural gas cannot be the whole climate solution – over the long-term, much deeper decarbonization is needed than switching from coal to gas can achieve). Even in places where concerns about and belief in climate change are low, no one thinks it is a good idea to leak methane and waste an important and valuable domestic energy resource.

Significant methane leakage along the natural gas value chain and from oil wells could call into question the net impact of gas on the climate. Given that natural gas will likely be relied upon for decades, it is essential to continue to build on progress in reducing methane emissions and make gas part of the climate solution.

Although the emissions factors in use today are often outdated, there is new data emerging regarding methane emissions from shale production. The data gap is being filled somewhat now by the 16 studies the Environmental Defense Fund (EDF) is doing involving

about 100 universities, research institutions, and oil and gas companies across the entire value chain to get a better understanding of methane emissions and sources. The first of the EDF studies, published in 2013 in partnership with the University of Texas and others, measured methane emissions from 190 drilling sites in the US and found that overall emissions from natural gas production were similar to previous EPA estimates, though emissions from certain sources were much higher. (The study found that flowback emissions are lower than EPA estimates but that pneumatic and equipment leaks are higher.) The EDF study also indicated that emission control technologies, such as green completions, are available and effective.[1]

The studies can help industry, regulators, and stakeholders identify where emissions are coming from and how to reduce them to the greatest extent possible subject to economic and technical feasibility.

There are some other studies out there too. The most recent EPA inventory showed a leak loss rate of about 1.3% (0.36 tcf) across the natural gas value chain, representing about $1.5 billion per year in lost product revenue, and the EPA's estimate is on the lower end of the spectrum.[2] A study from Cornell that estimated the methane leak rate to be much higher than the EPA's estimates, meaning natural gas would be worse than coal in a climate sense, is what initially boosted the profile of the methane issue.[3] Some top-down studies show much higher levels of methane leakage, and there are efforts underway to try to reconcile the top-down and bottom-up methane measurements. Several studies talk about super-emitters or fat tails – i.e., the small number of sources that produce a large percentage of the methane emissions – and studies that report

1 David T. Allen et al, "Measurements of methane emissions at natural gas production sites in the United States", *Proceedings of the National Academy of Sciences*, vol. 110, no. 44, 17768–17773 (2013).

2 US EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012" (April 2014).

3 Robert W. Howarth et al, "Methane and the greenhouse-gas footprint of natural gas from shale formations", *Climatic Change,* Letter, 106:679–690. doi: 10.1007/s10584-011-0061-5 (2011).

average leakage numbers may not adequately convey the importance of these super-emitters.

All of these studies could feed into a binary framing of the issue – if methane leakage is too high, then gas is worse than coal and should not be developed, but if leakage is low, then it should be developed. That kind of framing would be unfortunate. The studies can help industry, regulators, and stakeholders identify where emissions are coming from and how to reduce them to the greatest extent possible subject to economic and technical feasibility. Indeed, even as studies have continued, conversations started shifting around 2013 from whether there is a need to reduce methane emissions to how to do it.

Colorado, for instance, adopted in 2014 a comprehensive LDAR program to control "fugitive" emissions from oil and gas operations, the first in the nation to explicitly include a focus on methane; other states, such as Ohio and Wyoming, quickly followed Colorado's lead and initiated similar regulatory action.

Policy action on methane is beginning at the state and federal levels, including the EPA issuing white papers on upstream methane that would let the agency do rulemaking by the end of the Obama Administration, DOE supporting basic science and lifecycle GHG analysis and convening roundtables to firm up understanding of methane leakage, the Department of the Interior looking at a rule on waste mine methane reduction, and lots of action in states on issues like fugitive emissions, leak detection and repair (LDAR), inspections, green completions, and storage tank management. Colorado, for instance, adopted in 2014 a comprehensive LDAR program to control "fugitive" emissions from oil and gas operations, the first in the nation to explicitly include a focus on methane; other states, such as Ohio and Wyoming, quickly followed Colorado's lead and initiated similar regulatory action. It should be noted that there is no particular reason why methane regulation has to happen at the state level as opposed to the federal level; air regulations have

historically been nested in the federal Clean Air Act, and methane regulation is not like well integrity, where geophysical differences from place to place require local knowledge. Still, the states have taken the lead, as they almost always do, and the states can set the table for what the federal methane framework will look like.

Sometimes state policies provide disincentives to dealing with methane leakage, and some states are taking a leadership role in addressing them. For instance, some public utilities commissions have capped the amount of money that distribution companies can get back for "lost gas", which instantly changes the economic incentives associated with methane leakage. State or federal technology-based policy approaches also need to take heed of super-emitters and avoid mandating a one-size-fits-all technological approach that does not account for realities such as different types of pneumatics potentially needing different types of valves.

There are industry efforts underway to find solutions to the methane issue as well. Leading companies are taking action, including collaborating with others (e.g., EDF, ARPA-E) on research to get a better understanding of methane emissions, participating in the EPA's Natural Gas STAR program, pursuing LDAR programs, and participating in efforts to find low-cost methane detection systems. In addition, companies across the natural gas value chain – production, processing, transmission, and distribution – have joined forces under ONE Future (Our Nation's Energy Future) to tackle a range of common concerns, and the first initiative is focused on air issues (next will be water, followed by community impacts). Companies in ONE Future have voluntarily committed to a methane leak loss rate of less than 1% across the value chain, an achievable goal that was set in order to have natural gas be better than any other hydrocarbon. These industry efforts have economic benefits and enhance a company's social license to operate. Despite the economic and social license benefits, it is an open question whether more companies will take action and whether industry and environmental stakeholders will be willing to collaborate at a national level; doing so requires courage and a willingness to step away from the pack and suffer the slings and arrows that will surely come.

Water And Land Impacts

The impact of shale gas and oil production on air pollution and methane emissions is high on the policy agenda. The next big issues may well be the impacts of production on water and land.

Water Impacts

States and commissions, especially in places experiencing droughts, have been very focused on water. Regulators are not where they would like to be in terms of understanding water availability and the industry's water impacts, and the water resource needs and impacts (both at the surface and below ground) from shale oil and gas production need to be better understood, measured, and managed. This is not to say, however, that water issues are new for state regulators. Many states have had rules in place for decades to address industry water use and water impacts, such as rules about casing for wells or water recycling, but some of these rules have not been revisited in a long time and may need updating to reflect the industry's current practices.

In many places, there are no reporting requirements on the source of the water used for hydraulic fracturing, and better reporting of the sources of water for shale oil and gas operations would be helpful in assessing the industry's impacts on water supplies. Recent research appears to show that more water is being used presently in oil production –because hydraulic fracturing has greatly expanded oil production overall, not because hydraulic fracturing techniques are using more water per unit of oil production than conventional

techniques (though there are wide differences in water use in different shale plays). [1] Although the amount of water used for shale development is often a small percentage of overall use in a given region, it can still be significant at the local level, especially in water-scarce areas. It also seems that hydraulic fracturing can depressurize aquifers, potentially dropping water levels a significant amount after only a few years of production.

Recent research appears to show that more water is being used presently in oil production –because hydraulic fracturing has greatly expanded oil production overall, not because hydraulic fracturing techniques are using more water per unit of oil production than conventional techniques (though there are wide differences in water use in different shale plays).

Droughts are not going away, so water issues are something the industry can and should get in front of. Industry has been figuring out how to use less water in fracking, such as recycling more water and using brackish water where possible. Some companies are fracking with 100% produced water and are talking with communities and state regulators about allowing use of gray water. Some are aiming to be freshwater neutral (though the definitions of "freshwater" or "usable water" or any number of other similar terms differ significantly from state to state – or from agency to agency within a state). Some companies in the industry are very public in their efforts to be part of the solution to droughts, but others in industry often argue that droughts are not their fault and water use is not their responsibility. Some companies are also resistant to sharing data on water practices with academics, even if they are implementing good practices and sharing those practices with other companies. Since the industry will be around for decades, it needs to think about water as a resource over decades and what its water needs and strategies will be.

1 B.R. Scanlon et al, "Comparison of Water Use for Hydraulic Fracturing for Unconventional Oil and Gas versus Conventional Oil", *Environmental Science & Technology,* 48 (20), pp 12386–12393, DOI: 10.1021/es502506v (2014).

There are also concerns about the impacts to overall water quality – groundwater quality, in particular – from development of shale resources in certain areas. With the boom in shale development, the amount of wastewater injected into wells has been increasing dramatically in some states over the past decade. Again, leading companies are increasing their water recycling, thereby reducing the amount of wastewater going into injection wells. (If this results in a decrease in induced seismicity – assuming that there is a connection between injection wells and earthquakes – then so much the better.) Some leading companies are also working with conservation and environmental organizations on well bore integrity projects and erosion control programs.

Leading companies are increasing their water recycling, thereby reducing the amount of wastewater going into injection wells.

A big issue when it comes to water quality concerns is the tension between disclosure of the chemicals in fracking fluid and trade secret status. Just because a company might legally be allowed to claim a trade secret does not mean it should. There are some movements by states and within industry, including service companies, to greatly reduce the number of trade secret (or confidential business) claims. The improved version of FracFocus will be very attentive to trade secret issues and will do everything short of changing state laws to minimize the use of trade secret claims.

The risk-based data management system (RBDMS) that most oil and gas producing states are using has an environmental component that will include a water aspect, enabling activities such as tracking the results of water sampling events over time to see if there are any changes occurring to baseline water conditions and volumes. Other tools exist as well. The Global Environmental Management Initiative created a Local Water Tool for oil and gas operations that allows companies to look at basin operations, business risks, water sourcing, water management practices, discharges, and all kinds of external impacts on water. The tool also allows for comparison of companies. In addition, the technology exists to do continuous

monitoring for methane and chemicals at wells, and a pilot project with that technology is now underway. If the data show a lack of impact on groundwater, it will be interesting to see how that finding affects community reactions.

Land Use Impacts

Part of the industry's impact comes from the sheer scale of shale development and the associated land use changes taking place. Each three-acre well pad has a footprint of about 30 acres when associated infrastructure (e.g., roads, gathering lines, pipelines, water storage facilities) are included, and there are tens of thousands of wells being developed annually. Given the lifespan of the industry, there will be millions of acres of land disturbance, which may be spread out in some places but concentrated in others. Some lands are easier to mitigate and restore than others, and it is not even clear in some states which agencies are in charge of land restoration.

That level of land disturbance will greatly increase the number of acres changed to an impervious surface (either pavement or compacted soil), which can have impacts on soil erosion, drainage, sedimentation, surface hydrology, and other aspects that affect a watershed's health, not to mention the species in that watershed. Additional research is needed to identify threshold limits or conditions that could portend real shifts in water and habitat quality. There is also a need for tools that can help determine how best to integrate ecological data into the placement of infrastructure (i.e., a low-impact site optimization tool) and for ecological flow thresholds that can address water quantity concerns in water withdrawal permitting. While companies can do a lot with their own practices to reduce land use impacts, much of the burden will fall to states to figure out how to do anything other than a piecemeal permitting process that fails to look at cumulative watershed impacts.

Changing The Conversation

The current conversation about shale gas and oil development, high-volume hydraulic fracturing, and horizontal drilling is extremely vitriolic and characterized by extreme distrust on all sides. It is an open question whether that conversation can be changed to enable coherent policies that can lead to more environmentally sustainable production of these hydrocarbons.

Drivers of the Conversation

The industry has been doing horizontal drilling and hydraulic fracturing for many years. The key difference recently has been the change in the order of magnitude, which has gotten the public much more involved in conversations about shale development. In the past few years, there has been an increased focus on the environmental, health, and welfare impacts related to development of shale oil and gas. Initial concerns focused primarily around the potential for hydraulic fracturing to contaminate water and have started to shift to water availability, given hydraulic fracturing's water needs. There are also more concerns now about induced seismicity, air issues, methane emissions, and cumulative impacts on land and property. In Pennsylvania for instance, gathering pipelines have grown in size and proliferated rapidly, with tens of thousands of miles of pipeline being put in over the space of just a few years. Because these gathering lines are not regulated, the public does not have an opportunity to say anything about this massive and sudden

proliferation or where lines should or should not go, which can be a huge source of frustration.

In addition to the enormous growth in activity, another key driver of conversation has been the increasing collisions between the industrial and community worlds. Public opinion and public debate can be affected by how comfortable populations in certain areas are with oil and gas development and by how recently development has occurred. Over the past few years, oil and gas development and community development have begun bumping into each other. Technology has increased industry's ability to extract resources from areas it previously could not (and that therefore have not seen the industry or the issues associated with new technologies before), while bedroom communities have expanded out to areas where the industry historically has been. And the reality is that this is heavy industry, which can create a range of nuisances, such as noise, lights, smells, and truck traffic, that nearby communities may not want to deal with in their backyards for years upon years.

In the past few years, there has been an increased focus on the environmental, health, and welfare impacts related to development of shale oil and gas.

There are many issues that are stoking concern, and the industry and regulators generally have not been ahead of them. The issues surrounding the safety of transport of Bakken crude by rail, for instance, could have been foreseen and researched ahead of time to address public concerns, but they were not. On the horizon are issues around the re-working of mature oil and gas basins (especially oil) in the United States and around the world, many of which are approaching declining productivity and are places that have not seen much activity in recent decades, which means it would be good to get ahead of any community concerns.

There is also the issue of history and memory. Someone who had an encounter with a bad actor in industry 20 years ago (e.g., industry came in and ruined my garden) will have a lingering distrust.

It is worth noting that there may be little overlap between what people in some states and cities are worried about and what the real problems are with respect to hydraulic fracturing. In Los Angeles, for instance, the problem is not fracking per se but rather broader questions about oil and gas production in the middle of a city. In the Monterey, people should perhaps be worried about the regulations on what water can be used for agriculture and the lack of regulations on measuring the constituents in produced water, since produced water is being mixed with agricultural water and is going into producing the food people eat. While there are real risks to worry about, they may not be the issues on which people fixate. It is hard for industry and regulators to know what the next issue is that the public imagination will take hold of.

Polarization

Driven by a range of concerns, communities have become much more involved, activists have become more vocal, and the issue has become more polarized and political. There are a lot of shrill voices on both sides.

On the anti-fracking side, a lot of what stakeholders are saying about shale gas and oil is just flat wrong. There is a great deal of misinformation and hysteria. Early on, the activist community did a thorough job of confusing the public by misusing the words "hydraulic fracturing", and it has taken a while to unravel some of that. In addition, those who were counting on fossil fuels to disappear so renewable energy, energy efficiency, or other forms of energy could replace them have attacked every weakness they can find related to shale development, and those weaknesses should in fact be addressed (and are, though not aggressively enough). But the anti-fossil-fuel crowd feels – almost religiously – that whatever it does to get rid of fossil fuels is justified, so there is a lot of demagoguery and little civility.

The impact of the internet cannot be underestimated, as the larger conversation on shale development that is occurring on the internet has played a big, largely unfortunate role in aiding the spread of misinformation. It can be a challenge to get good, solid,

fact-based information into that conversation. There is a similar conversation occurring in the press, and the influence that New York and California have in the media also cannot be understated. The perspectives of producing states such as Oklahoma and Texas do not get represented nearly as well, and potential benefits of shale development do not receive nearly as much media coverage as potential impacts. That being said, polarization on these issues is not just happening on the coasts.

In such a polarized and vitriolic environment, with both sides retreating to their corners, there is little serious dialogue, and facts and data tend to get very little traction.

Responsibility for the polarization also does not fall solely on the activist community. There is something of an equivalent on the industry side as well. For instance, industry often shoots itself in the foot with its communications efforts and its defensive posture and regularly disregards the need for additional or better regulation. On induced seismicity, there are trained industry engineers who outright reject the idea that they can cause an earthquake. Similarly, the industry's early opposition to full disclosure of what is in fracking fluids was a terrible public relations move, as the lack of transparency has affected the industry's social license to operate ever since – even after good disclosure laws were enacted in some states. There are times that industry silence is equally problematic. For instance, there is an issue in some states concerning what to do with naturally occurring radioactive materials, which is an eminently manageable issue, and yet no companies talk about it publicly, which raises concerns among the public. Another key weakness of the oil and gas industry is that by and large it does not recognize climate change, which generational change will eventually address.

The polarization is exacerbated by lack of trust. Polling indicates that the public does not trust industry – oil and gas companies rank below Congress in terms of trustworthiness – and does not particularly trust regulators either, and both companies and regulators have

done a terrible job of getting in front of issues and explaining what they do. On the other side, industry tends to view anti-fracking activists as misinformed extremists.

In such a polarized and vitriolic environment, with both sides retreating to their corners, there is little serious dialogue, and facts and data tend to get very little traction. It is increasingly the case that stakeholders that already have a firm viewpoint will attack and try to undermine the sources of studies with which they disagree. There is only a narrow audience that wants objective information; many people have already made up their minds. In addition, most academics are not equipped to deal with how their work is translated, spun, and used in policy and dialogue spaces. Academic studies are sometimes released in ways that are neither strategic nor thoughtful, and the authors end up surprised when the public and/or advocates take the studies and run with them in directions that the authors never intended.

Perpetuating the polarization is the funding community, which repeatedly funds the extremes to continue their lines of argument. Climate and energy funders seem to be singularly obsessed with methane and with whether new supplies of natural gas will preempt burgeoning markets for renewable energy. While environmental grant-makers fund the anti-fracking activists, industry has its own ample resources to ensure that its messages are delivered. The poles are thus well-funded and want to destroy each other, leaving little funding for issues such as what to do about water and little room in the middle to solve problems. It all becomes a vicious cycle instead of a virtuous cycle.

Building a Constructive Center

The conversation will improve if it gets outside the fringes and comes together in a middle ground that makes sense, but the conversation may not evolve until those involved bring the same passion to being pragmatic and solution-oriented as those on the fringe bring to the extreme. Whatever "center" exists now is tenuous, but there are efforts underway to try to grow what could be thought of as a radical center of passionate pragmatism.

Far too few people on the environmental side and on the industry side are truly interested in sitting down, talking, and figuring out what needs to be done to ensure responsible shale production. But smart people who can get a drill bit to track through a narrow shale formation and who can drill in thousands of feet of water ought to be able to help come up with solutions to these contentious issues, with input from all sides (beyond just industry versus environmentalists). The conversation has to move beyond the zero-sum-game framing of the economy versus the environment; both can be pursued at the same time. There is lots of work to do to get people to stop talking past each other and to stop staking out and defending their territories. There is a need to embrace the idea that everyone is in this together and has to find solutions.

The conversation has to move beyond the zero-sum-game framing of the economy versus the environment; both can be pursued at the same time.

The industry, for instance, needs to spend less time minimizing the public's concerns and more time communicating the real risks and what it is doing to mitigate them. The industry has been really good at quantifying the benefits of shale gas and oil, with lots of data-driven maps about the stimulus to the economy and the jobs created. While those are valid points, when the conversation turns to the risks, it becomes much more qualitative. It could help the conversation if the industry was collecting data, doing real-time monitoring, and publicly talking about the evidence concerning what air, health, or other impacts actually are based on real data and not just the latest public craze. In addition, industry tends not to admit past or current mistakes; doing so might help the dialogue but might also open the industry up to litigation. More generally, to realize the promise of these abundant resources, the industry has to secure the public confidence that they can be produced responsibly and prudently.

To have any hope of influencing public opinion, there has to be an ongoing story to tell about the benefits of the shale revolution. Industry has a pretty good story it can tell – about securing

America's energy future, reducing imports of oil and gas, getting the most out of the country's natural resources, boosting the economy, minimizing impacts on air and water, cleaning up tens of thousands of old sites, easing Europe's reliance on Russian energy, improving lives, reducing costs, and helping to address climate change. Industry, however, has done a terrible job of telling the story, and regulators cannot tell the story for them for fear of being perceived as being in the industry's pocket.

The scientific community, too, needs storytellers who can make information understandable in a way that resonates with the psyche and emotions of the public. Scientists may also want to more aggressively pursue opportunities for joint fact-finding, with an array of stakeholders conducting research; it is impossible to control spin, but it is possible to create institutional structures that provide an up-front defense against it.

Without head-on engagement of the emotional elements of the debate first, the science and data that could help devise appropriate regulatory structures become irrelevant. Addressing the emotional side is necessary for creating a listening environment.

Science and data can play a part, but only a part, in improving the conversation. Without head-on engagement of the emotional elements of the debate first, the science and data that could help devise appropriate regulatory structures become irrelevant. Addressing the emotional side is necessary for creating a listening environment. The science is important, and more studies are needed, but the issues at play in these conversations are about tradeoffs that ultimately come down to values. There is emotion on both sides – communities are worried about the safety of their families, while industry feels it gets no appreciation for providing the fuels that keep everyone warm. The internet fosters and amplifies the emotional aspects of the conversation far more than the science side. There needs to be up-front recognition of all the difficult emotions involved and encouragement to work through them to find actual answers.

The Path Forward

Going forward, there must be continued focus on the process of continuous improvement for state regulatory programs, the need for the industry to tell its story better, and how to educate and engage the public. For instance, there are lots of unrealistic expectations among the general public about where things stand with alternatives to fossil fuels and what can be accomplished in the short term, and there is a need to get people to understand the energy they use and where it comes from.

The effort to move to a more centered conversation might benefit from taking a longer view, recognizing that modern shale gas will be a key part of the energy economy for decades to come. Even with climate action, fossil fuels are projected to be two-thirds of the global energy mix in 2035, which means shale gas will be needed for quite a while.

The effort to move to a more centered conversation might benefit from taking a longer view, recognizing that modern shale gas will be a key part of the energy economy for decades to come. Even with climate action, fossil fuels are projected to be two-thirds of the global energy mix in 2035, which means shale gas will be needed for quite a while. The shale boom is still at the early stages, and if the industry does 30,000 wells a year for decades, there are real impacts and public reactions

to be considered. There is likely a need to take more of a long-term, cumulative, play-based and/or watershed-based approach, involving all the stakeholders to generate a collective understanding of and mitigation options for the unique environmental and social risks of increased drilling and the associated volume of infrastructure. (There are opportunities in states now to take more of a play-based approach via the Bureau of Land Management's master leasing plans, a process that is not yet being utilized to its utmost.) Taking a long-term view highlights the need to find actual solutions to the issues shale development raises and to think about the institutional structures and scientific research that will be needed over that timeframe.

Discussions about addressing the issues surrounding modern shale production need to involve the oil field service companies, who are a critical part of the lack of disclosure. The discussions would also benefit from greater involvement by financial institutions to enhance understanding of how financing for shale has changed over time, what the future looks like, and how they are engaging with companies regarding environmental impacts. The royalty owners' association would be another important group to bring to the table, as the mineral interest owners are among the key people profiting from shale production. In addition, small producers who are not yet taking action are valuable voices to add to the mix, to increase understanding about the causes of inaction and the challenges associated with being small. Similarly, local government officials are critical actors to include, as no one is in more of a rock-and-a-hard-place situation than they are, and they often lack the regulatory, financial, and human capacity to engage with all stakeholders.

Discussions also may need to focus more squarely on community impacts, as those are the source of so much of the controversy around shale production. Some of the community impact concerns can be addressed through technological methods, but others are about process, how to deal with local communities, and how to actually hear their concerns – and, again, how to get the message out to them. It could be valuable to look at best practices to see what states and industry have done that has worked in terms of helping to further discussions and engage in dialogue in ways that resonate.

Appendices

Agenda

MONDAY, JULY 21

9:00 – 9:15 AM **Introduction: Purpose and Process**

David Monsma, Aspen Institute
Bill Budinger, Rodel Foundations
Marilu Hastings, The Cynthia and George Mitchell Foundation

9:15 – 10:30 AM **Session One:**
Setting the Tone, Changing the Conversation

Shale gas and oil development has increased public exposure to and concern about hydraulic fracturing and horizontal drilling activities. Public statements by some in both the producer and environmental communities contribute to distrust even as the federal government, some states, and some producers and producer groups seek to define an appropriate regulatory regime.

An initial proposition for this forum is whether and how ***the debate and conversation surrounding the use of high-volume hydraulic fracturing and horizontal drilling in the development of shale gas and oil can change from all-or-nothing propositions to***

coherent policies informed by science and that lead to a more environmentally sustainable production of these hydrocarbons?

David Monsma, Aspen Institute
Marilu Hastings, The Cynthia and George Mitchell Foundation

Discussants:
Lori Wrotenbery, Oklahoma Corporation Commission

Gerry Baker, Interstate Oil and Gas Compact Commission

Scott Anderson, Environmental Defense Fund

Paula Gant, US Department of Energy

10:45 – NOON **Session Two: "Data Room" – Market Structure and Regulatory Trends**

Industry generally believes that regional geological differences require regulations accounting for these variations and that states are best suited to develop and enforce regulations that keep up with the rapid change in technology. Others are optimistic that some state regulations need updating and/or that there should be economy-wide minimum standards with regard to certain environmental risks. Clear, science-based regulations specific to each region reflecting the responsibility for ensuring the sustainable development and production of all hydrocarbons are in the best interests of all.

This session will serve as a baseline for the forum by providing an abridged but data- and evidence-driven overview of upstream and mid-stream natural gas development, production and markets in the US, including some of the top-line regulatory policy issues.

Moderator:
David Monsma, Aspen Institute

Discussants:

Global Picture	**Jason Bordoff,** Columbia University
International Action	**Cal Hill,** Alberta Energy Regulator
Regulatory and Infrastructure Challenges	**Heather Palmer,** Bracewell & Giuliani
Market Observations	**Granville Martin**, JP Morgan Chase

1:30 – 3:00 PM **Session Three: The Regulatory Exchange**

Last year, the Texas Railroad Commission adopted new rules (Rule 13) for mechanical integrity. New cost-effective air pollution standards have been adopted in Colorado to reduce emissions of methane and VOCs; Ohio proposes to tighten the rules on air emissions from natural gas-oil drilling at horizontal wells. This session introduces the discussion on how state regulators and market operators manage environmental risks that may arise from individual projects and cumulative developments. What combination of environmental management practices and regulatory modernization is anticipated (or needed) over the next two to three years in major producing states? What constitutes a rigorous process of continuous improvement for over-all air quality; water quality and quantity; and methane emissions?

Moderator:
Doug Arent, National Renewable Energy Laboratory

Discussants:

The Regulatory Exchange	**Mike Paque,** Groundwater Protection Council
Internal State Review	**Jane Long**, California Council on Science and Technology
Integrating Geoscience	**Nick Tew**, Alabama State Geologist and Oil and Gas Supervisor

3:15 – 5:00 PM **Session Four: Air Quality**

Oil and gas production is a source of air pollutant emissions linked to a wide range of health effects and public concern about these emissions is growing especially in regions that have experienced rapid development of shale resources. Emissions can vary widely and current methods for estimating and regulating them may need refinement. How can oil and gas production from shale lead in the overall reduction of air pollutant emissions in a manner that addresses true threats and still helps improve over-all air quality?

Moderator:

Jonathan Banks, Clean Air Task Force

Discussants:

Federal Action	**Kate Konschnik**, Harvard Law School Environmental Policy Initiative
State Action	**Martha Rudolph**, Colorado Department of Public Health and Environment
Upstream Regulation	**John Baza**, Utah Division of Oil, Gas and Mining

TUESDAY, JULY 22

8:30 – 9:00 AM **Powering Forward**

Remarks by **Bill Ritter**, Center for the New Energy Economy & former Governor of Colorado

9:00 – 10:30 AM **Session Five: Water Quantity and Quality**

The water resource needs and impacts (both at the surface and below ground) from shale oil and gas production need to be better understood, measured and managed. Although the amount of water used for shale development is often a small percentage of overall use in a given region, it can be significant at the local level where fresh water availability can vary widely. Non-trivial concerns remain about the impacts to overall water quality – groundwater quality, in particular – from development of shale resources in certain areas. What would a comprehensive water quantity and quality monitoring program need to include?

David Monsma, Aspen Institute
Marilu Hastings, The Cynthia and George Mitchell Foundation

Discussants:

Well Construction	**Christi Craddick**, Railroad Commission of Texas
Risk Based Data Management System	**Stan Belieu**, Nebraska Oil and Gas Conservation Commission
Balancing Multiple Needs	**Michael Teague,** Oklahoma Secretary of Energy and Environment

	Spatial Planning	**Nels Johnson**, Nature Conservancy

10:45 – NOON **Session Six: Methane Emissions**

The sustainability of the oil and gas boom from shale depends in part on informed public acceptance of the environmental risks and impacts. Some recent estimates of methane leakage from natural gas production and transportation have led to commentary challenging the benefits of switching from coal to natural gas, a large near-term greenhouse gas reduction opportunity. Regardless, reducing leaks of methane is a logical business priority and economic opportunity for the oil and natural gas industry but how can questions be resolved about the overall effectiveness of current methane emissions control efforts?

Moderator:
Richard Newell, Energy Initiative, Duke University

Discussants:

NGO Perspective	**Matt Watson**, Environmental Defense Fund
Regulator Perspective	**Matt Lepore**, Colorado Oil and Gas Conservation Commission
Corporate Perspective	**Jim Bolander**, Southwestern Energy Company

1:30 – 3:00 PM **Session Seven: Observations and Next Steps**

Economic production from tight oil formations requires the same hydraulic fracturing and often uses the same horizontal well technology used in the production of shale gas. Nearly all of the environmental risks, technical requirements and business practices that pertain to the use of high volume hydraulic fracturing in the development and production of shale gas and oil, also apply to conventional oil and gas development and production, though some to different degrees.

Some states already have imposed more comprehensive rules on the oil and gas industry. Others have imposed moratoria or are considering new regulations. Contentious debates or additional accidents, however small, risk jeopardizing the potential of shale gas to meet economic and environmental goals. Findings by industry groups or environmental activists alone do not have the credibility that a broad-based stakeholder group would have, either with regulators or the public.

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Marilu Hastings, The Cynthia and George Mitchell Foundation

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