Introduction

James R. May and John C. Dernbach

This book addresses whether and to what extent shale gas development can occur in a sustainable fashion, that is, in a way 'that meets the needs of the present without compromising the ability of future generations to meet their own needs.'[1] It assesses the role that sustainability plays in decision-making respecting shale gas development in the U.S. and elsewhere, and offers recommendations for developing shale gas – to the extent it occurs – in a more sustainable way. More broadly, it addresses the role that shale gas can play in accelerating the transition to sustainability.

THE GROWING IMPORTANCE OF UNCONVENTIONAL SHALE GAS

Sustainability and energy are inextricably intertwined. Issues surrounding the extraction, generation, and distribution of energy have a profound influence on political institutions and the human condition around the globe. In less than two decades, a convergence of technology, market forces, and political factors has augured a new and unconventional method of recovering natural gas from deep shale deposits of natural gas, something to which we refer to as 'unconventional shale gas development,' or simply shale gas development.[2] Unconventional shale gas development is driving local, state, national, and even international conversations about the planet's energy future, and sustainability.

[1] World Commission on Environment and Development, Our Common Future 43 (Oxford and New York: Oxford University Press 1987).

[2] A number of other terms (hydraulic fracturing, fracturing, and fracking, among others) are sometimes used as synonyms for unconventional shale gas development or shale gas development. The latter two are more accurate, and we will use those terms here.

The story of shale gas begins with what is known as a deep underground shale 'play,' often roughly a mile deep below the surface of the Earth. In shale plays, organic matter in the soil generates gas molecules that absorb onto the matrix of the rock. Over time, tectonic and hydraulic stresses fracture the rock and natural gas (for example, methane) migrates to fill the fractures or pockets. The trick is how to reach and then capture this embedded natural gas in a commercially viable way.

Two basic approaches permit developers to reach the shale plays. The first, known as conventional shale gas development, ordinarily involves drilling vertically into a shale play, and then injecting millions of gallons of 'slickwater' (a combination of water, chemicals, and sand-like 'proppant') under high pressure (as much as 14,000 pounds/square inch) into the shale play to create small fractures, thereby releasing the natural gas embedded within. Fractures in the rock and naturally occurring gas pockets are, however, typically insufficient in size and number to sustain consistent industrial production of natural gas using conventional techniques.

Unconventional shale gas development, on the other hand, offers the potential for commercially viable production of natural gas from shale plays. It begins much the same way as conventional methods, that is, with a vertical drill bore that reaches the play. What happens next is what makes it 'unconventional.' After drilling a vertical hole to 5,500 to 6,500 feet below the surface – several hundred feet above the target natural gas pocket or reservoir – the drill bit is then redirected through an arc until the drilling proceeds *horizontally* through the heart of the play. Hydrofracturing from the horizontal drill bore results in a much higher yield of natural gas compared to conventional methods. While vertical or conventional techniques have been used for nearly 70 years, unconventional shale gas development was first deployed on a large scale around the year 2000 in the Barnett shale play in Texas.[3]

Unconventional shale gas development typically requires more of everything used in vertical hydraulic fracturing, including water, chemicals, piping, and risk. Unlike conventional gas development, it ordinarily entails installing several wells on a given pad and can yield millions of cubic feet of natural gas per day. This increased capacity makes it

[3] U.S. Energy Information Administration, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States* 13 (2013), accessed 27 Aug. 2015 at http://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf.

'unquestionably a game-changer in North America with potentially significant implications for the rest of the world.'[4]

Unconventional shale gas development has grown rapidly, especially in North America. For example, U.S. production has grown 'from 0.3 trillion cubic feet in 2000 to 9.6 trillion cubic feet in 2012.'[5] The number of wellheads has correspondingly grown exponentially. For example, the number of wellheads in Pennsylvania jumped to nearly 2,000 in 2011 from roughly eight in 2005.

The United States and Canada are the two top producers of 'commercially viable natural gas from shale formations.'[6] In 2012, shale gas production was 39 percent of total U.S. gas production and 15 percent of total Canadian gas production. China's shale gas production is less than 1 percent of its overall production, and a dozen other countries have done exploratory drilling.[7]

The potential for global shale gas production, however, is considerable. Table I.1 shows the ten countries with the largest technically recoverable shale gas reserves. China, Argentina, and Algeria are the top three, followed by the U.S. and Canada.

United States and Canadian production have been greatly aided by several factors. Property rights to gas reserves are privately owned, which means that they are easier to exploit than reserves held by the government, as they are in most other countries.[8] The U.S. and Canada also have a significant existing natural gas pipeline infrastructure, which means that shale gas-producing wells only need to be hooked up to existing pipelines.[9] Many other countries (including China) have shale

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[4] International Energy Agency, Press Release, *The Time Has Come to Make the Hard Choices Needed to Combat Climate Change and Enhance Global Energy Security, Says the Latest IEA World Energy Outlook* (10 Nov. 2009), accessed 21 Sept. 2015 at http://www.iea.org/newsroomandevents/pressreleases/2009/november/2009-11-10-.html.

[5] Id.

[6] U.S. Energy Information Administration, *North America Leads the World in Production of Shale Gas* (23 Oct. 2013), accessed 16 June 2015 at http://www.eia.gov/todayinenergy/detail.cfm?id=13491.

[7] Id.

[8] Zhongmin Wang and Alan Krupnick, US Shale Gas Development: What Led to the Boom? (Washington, D.C.: Resources for the Future 2013), accessed 21 Sept. 2015 at http://www.rff.org/RFF/Documents/RFF-IB-13-04.pdf.

[9] Id.

Table I.1 Top ten countries with technically recoverable shale gas resources[10]

Rank	Country	Shale Gas (Trillion Cubic Feet)
1	China	1,115
2	Argentina	802
3	Algeria	707
4	U.S.	665 (1,161)
5	Canada	573
6	Mexico	545
7	Australia	437
8	South Africa	390
9	Russia	285
10	Brazil	245
World Total		7,299 (7,795)

that is harder to exploit or lack the water needed for hydraulic fracturing.[11] In spite of these hurdles, there is considerable international interest in exploiting shale gas.[12]

SHALE GAS AND SUSTAINABLE DEVELOPMENT

The rapid growth of shale gas development has led to an intense and polarizing debate about the merit of shale gas. On one hand, national and subnational governments, the gas industry, and others often describe in glowing terms the economic and security benefits of shale gas as well as its potential to reduce greenhouse gas emissions. On the other hand are those who call for a moratorium, depicting shale gas production as

[10] U.S. *Energy* Information Administration, *Shale Oil and Shale Gas Resources Are Globally Abundant* (10 June 2013), accessed 16 June 2015 at http://www.eia.gov/todayinenergy/detail.cfm?id=11611. Estimates for all countries are by the Energy Information Administration; the U.S. estimate in parentheses is by Advanced Resources International.

[11] Keith Bradsher, *China Takes on Big Risks in Its Push for Shale Gas*, NEW YORK TIMES, 12 April 2014.

[12] Guy Chazan, *North America Sets Pace that Others Will Find Hard to Match: Global Shale*, FINANCIAL TIMES, 14 October 2013.

environmentally damaging and destructive of communities, and who worry that shale gas is causing or will cause an increase in greenhouse gases.

To be sure, unconventional shale gas development has upsides and downsides. Natural gas burns more cleanly than does coal; thus developing shale gas can have human health upsides. Many also contend that combusting natural gas slows the rate of climate change, as it is a less potent climate change fuel than is coal. Unconventional shale gas development has also helped to make energy more affordable, and contributed to national security owing to increased domestic production in countries that are rich in shale plays.

Unconventional shale gas development, however, can have multifarious direct and indirect adverse environmental effects. Direct effects include water contamination, air pollution, and seismic activity. Indirect effects include loss of habitat, truck traffic, noise, and local social and economic disruption. The vast amounts of water that most forms of unconventional shale gas development require can also put stress on water supplies and exacerbate water scarcity. And the migration from wells of methane, a very potent greenhouse gas pollutant, contributes to climate change.

At the same time – and essentially independent of what is happening with shale gas – the U.S. and other countries have embraced sustainable development as both a decision-making framework and as a policy objective. It is a decision-making framework because it would integrate environmental protection and restoration with social and economic development, using cost internalization, the precautionary approach, and other principles. Sustainable development also combines two dominant policy objectives – development and environmental protection or restoration, and implicitly contrasts these with the undesirable present situation – unsustainable development.

There is thus a strong need to understand the relationship between shale gas development and sustainable development. As a recent review of U.S. sustainability activities concluded, shale gas 'combines three distinctive and challenging features for sustainability: it has emerged with breathtaking speed, it has enormous economic potential, and it raises a host of environmental and social issues that are not yet resolved.'[13]

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[13] JOHN C. DERNBACH, ROBERT ADLER, RACHEL ARMSTRONG, JENNIFER BAKA, ATHENA BALLESTEROS, GARY D. BASS, DONALD A. BROWN, CARL BRUCH, WYNN CALDER, FEDERICO CHEEVER, MARIAN R. CHERTOW, JAIMIE P. CLOUD, ILONA COYLE, ROBIN KUNDIS CRAIG, JULIAN DAUTREMONT-SMITH, MICHAEL DIRAMIO, CATHERINE EASTON, ANNE H. EHRLICH, JOEL B. EISEN, JONATHAN BARRY FORMAN, LYNN R. GOLDMAN, KIRK HERBERTSON, DIETER T. HESSEL,

PURPOSE AND PLAN OF THIS BOOK

This book is a first effort at filling the gap in the literature between unconventional shale gas and sustainable development. It systematically analyses and evaluates shale gas law and policy from a sustainable development perspective. It asks – and provides a set of recommended answers to – the question of what sustainable shale gas production would look like if it were conducted in a sustainable manner. It further assesses good practices about the role of law in fostering the sustainability of shale gas production in Pennsylvania and elsewhere, how these lessons translate to other jurisdictions, and what needs to be done if shale gas is to contribute to a sustainable future. This book is not about the unconventional extraction of oil from shale, but much of what is said about the sustainability of shale gas may also apply to shale oil.

While this book offers perspectives from around the globe, most of the chapters focus on the U.S., 'which is the only country with several decades of experience and long-term statistical records.'[14] Some of the U.S. experience discussed in this book, in turn, is based primarily on Pennsylvania, which is the second largest shale gas-producing state in the country.[15] Because there is widespread consensus about sustainability as a policy norm, this norm could serve as a useful point of departure for achieving some common ground on how to deal with shale gas development. This matters because other national and subnational governments will encourage or support shale gas development to the extent that it can be done in a sustainable way.

KEITH H. HIROKAWA, LEO HORRIGAN, FRANCES IRWIN, KEVIN KENNEDY, JOHN A. ('SKIP') LAITNER, JEANNINE M. LA PRAD, AMY E. LANDIS, ROBERT LAWRENCE, MARK D. LEVINE, REID LIFSET, ROBERTA MANN, BRIAN MCNAMARA, JOEL A. MINTZ, CRAIG OREN, BRADLEY C. PARKS, TRIP POLLARD, DAVID REJESKI, ED RICHARDS, J. TIMMONS ROBERTS, K.W. JAMES ROCHOW, PATRICIA E. SALKIN, JIM SALZMAN, BRENT STEEL, KURT A. STRASSER, SUSANNA SUTHERLAND, DAN TARLOCK, MICHAEL J. TIERNEY, JONATHAN WEISS, AND CHRISTOPHER WILLIAMS, ACTING AS IF TOMORROW MATTERS: ACCELERATING THE TRANSITION TO SUSTAINABILITY 37 (Washington, D.C.: Environmental Law Institute Press 2012).

[14] European Parliament, Directorate-General for Internal Policies, *Impacts of Shale Gas and Shale Oil Extraction on the Environment and Human Health: Executive Summary* 77 (2011), accessed 30 Oct. 2014 at http://europe ecologie.eu/IMG/pdf/shale-gas-pe-464-425-final.pdf.

[15] U.S. Energy Information Administration, *Shale Gas Provides Largest Share of U.S. Natural Gas Production in 2013*, accessed 16 June 2015 at http://www.eia.gov/todayinenergy/detail.cfm?id=18951.

No major book on sustainability and shale gas previously has been published, and none with the range of topics covered in this book. There is a rapidly growing popular and technical literature on shale gas development, including books, articles, and even films. Although the shale gas literature sometimes uses the sustainability framework to a degree,[16] it does not do so in any systematic way. Similarly, while there is a large literature on sustainability, it tends to be either fairly general or to focus in detail on specific sustainability issues other than shale gas (for example, sustainable forestry, sustainability in higher education, green building).[17] A few individuals and organizations are approaching specific sustainability issues related to shale gas, and these have provided the basis for some of the chapters of this book.

Within law, there have been numerous symposia on shale gas development, mostly published in law journals. These symposia, however, tend to focus on particular aspects of the sustainability issue (such as water quality and endangered species), and not on the overall sustainability issue. While there is a robust discussion of the environmental, social, economic, and security dimensions of shale gas, it has mostly occurred outside of academic law. Thus, the book also makes a contribution by putting in one place a law and policy discussion about the broad range of sustainability issues related to shale gas.

This book grows out of the first national conference in the United States on the confluence of shale gas development and sustainability, 'Marcellus Shale Development and Pennsylvania: What Lessons for Sustainable Energy?,' which was held on 27 September 2013 at Widener University School of Law in Harrisburg, Pennsylvania.[18] This book has a broader focus than the conference, including not only Pennsylvania and elsewhere in the U.S., but developments in other corners of the globe where shale gas development issues are emerging. The contributing authors are not only lawyers and current and former policy makers; they also represent public health, the social sciences, economics, and other disciplines.

This book attempts to provide an overall assessment of the extent of any gap between current laws and what is required for the sustainability

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[16] See, for example, VIKRAM RAO, SHALE GAS: THE PROMISE AND THE PERIL (Research Triangle Park, North Carolina: RTI Press 2012).

[17] But see Center for Sustainable Shale Development, accessed 16 June 2015 at https://www.sustainableshale.org/.

[18] For a recording of the conference, as well as PowerPoint presentations from the various speakers, see http://commonwealthlaw.widener.edu/marcellusshale2013/ (accessed 21 Sept. 2015).

of shale gas. It also attempts to describe as precisely as possible what laws and forms of governance are required for shale gas production to be truly sustainable. Toward these ends, the contributing authors were asked to address: (1) what sustainability means for their particular topic, (2) what various governmental entities and private sector parties are doing to foster sustainability on this topic, and (3) recommendations for ways to foster sustainable practices in shale gas development. Their 12 chapters are divided into five parts – public health and the environment; community; public participation, public information, and access to justice; governance; and energy and climate change. A final chapter synthesizes lessons for sustainability and shale gas from these chapters.

In Chapter 1, entitled 'Framing the Sustainability Questions,' John Dernbach outlines the origin and purposes of the concept of sustainable development, setting out the perspective that is employed in this volume and that should inform decision-making about shale gas development. Essentially, sustainable development is an effort to address simultaneously the planet's enormous environmental degradation challenges as well as great unmet human needs. It is not anti-development; it is directed at making development *sustainable*. This explanation is needed because the term is used in different ways by different authors. This understanding of sustainability or sustainable development (we use the terms interchangeably) is also based on an historic understanding of the term that is shared by sustainable development practitioners around the world.

PUBLIC HEALTH AND THE ENVIRONMENT

Part I discusses ways to protect public health and the environment from the adverse effects of shale gas development. In Chapter 2, 'Sustainable Drilling through Health Impact Assessment: Understanding and Planning for Public Health Impacts,' Pamela Ko and Patricia Salkin examine the nexus between sustainability and health. Ko and Salkin recommend that policy makers require a 'health impact assessment' (HIA) – that is, an assessment of adverse health impacts, alternatives, and risk avoidance – as a means to promote sustainable practices in shale gas development. They maintain that requiring an HIA for shale gas development would have multiple salutary effects, including 'promoting human health, reducing illness and disease, enhancing cross-sectoral coordination, and promoting greater equity in public health.'

Ko and Salkin describe a direct connection between health assessments and sustainable shale gas development, maintaining that an HIA 'can be

an integral part of a strategy to identify sustainability issues related to shale gas practices and can provide answers to questions surrounding the advancement of sustainable development practices in the area of unconventional gas extraction.' HIAs, they conclude:

> could also be used to evaluate the various stages of shale gas development, from clearing a site to the hydraulic fracturing and waste management to flaring, with such use providing better information on the economic, social and human health impact of each stage of the development to better inform decision-making at each step in the process.

Salkin and Ko maintain that HIAs could also play 'a crucial role in evaluating developments that might lead to increases in the well-being of the population or to increases in health and wealth inequalities' of shale gas development and thereby play 'an invaluable role in the development and implementation of strategies for sustainable drilling.' They conclude that HIAs can be used to promote sustainable practices, including optimizing benefits and minimizing or mitigating adverse health consequences to given 'target' populations, and hence promoting human well-being, the linchpin of sustainability.

Next, in Chapter 3, 'Requiring Full-cost Accounting for Environmental and Social Impacts,' John Quigley argues that to make shale gas development sustainable, policy makers ought to require developers to internalize economic, social, and environmental costs and risks from extraction to conversion in internal decision-making processes. Drawing from experiences in Pennsylvania, Quigley concludes that a 'business-driven approach would change the manner, scope, and depth of how shale gas companies make decisions about well field development, selection of technologies and practices to be employed, the prioritization of research and development, and investment in pilot projects,' thereby contributing to sustainable practices in shale gas developments. Such 'full-cost accounting,' Quigley maintains, 'would likely lead to the elimination of the use of water and chemicals in the hydrofracturing process,' which he views as both costly and accounting for 'a great many external social and environmental risks.' At present, he observes, developers 'by and large, do not appear to be integrating their accounting concerning internal costs and external risks.' 'Very simply, the business case for sustainability is not being made. The industry must go beyond current practice and quantify and internalize all of the risks and costs – which extend well beyond strictly environmental considerations – of water and chemical use in hydraulic fracturing that can impact company bottom line.'

Quigley recommends that policy makers consider four means for implementing full-cost accounting in internal decision-making as a means for advancing sustainable practices. First, developers could engage in full-cost accounting, 'perhaps even deciding that it offers a potential competitive advantage as industry consolidation occurs.' Second, shareholders, investors, and financial institutions demand full-cost accounting in corporate governance. Third, policy makers could require 'the industry either do full-cost accounting or explain publicly why it chooses not to do so.' Finally, and in the end, 'appropriate laws should mandate the adoption of the practice as part of corporate governance and disclosure requirements.'

COMMUNITY

Part II concerns the impacts of unconventional shale gas development on community sustainability. In Chapter 4, 'Sustainable Housing in Rural Communities Affected by Shale Gas Development,' Jonathan Williamson and Bonita Kolb address the deep link between available, affordable housing and sustainable shale gas development, with special emphasis on the Marcellus Shale region in the U.S. They explain that housing demand from shale gas development evolves in two phases, first for transitory workers and then for a more permanent workforce and concomitant development.

Williamson and Kolb observe that development and housing are inextricably intertwined. For developers, they conclude, 'the availability of sustainable housing improves' productivity and community acceptance. From a societal perspective, 'sustainability of a community and its housing should be as important as the sustainability of natural gas as a fuel source. Responses to housing impacts must not exclusively focus on short-term crises, but consider long-term community planning needs.' To achieve that result, they recommend that government and housing developers work together on a community-by-community basis to address the housing needs of the entire community, not just shale industry workers. They also recommend that community planning for housing take into account the rise and fall over time of demand from the shale gas industry.

In Chapter 5, 'Sustainability and Community Responses to Local Impacts,' Diana Stares, James McElfish, and John Ubinger, Jr. argue that whether shale gas development can occur sustainably is a function of the extent of local control. They advocate governance methods that 'provide a satisfactory process for local stakeholders to have constructive input to determinations affecting local resources, needs, and goals.' Focusing on

experiences surrounding the Marcellus Shale Play in Pennsylvania, they examine various community responses to shale gas impacts, and recommend outcomes based on 'collaboration and consensus.' To promote sustainable communities affected by shale gas development, they maintain that local officials should deploy local land use laws, meet early and often with developers, and consider development from a 'regional or area standpoint.' Under no circumstances, they conclude, should it be that 'communities have no authority or that operators are answerable only to the state/national government and to their investors.'

PUBLIC PARTICIPATION, PUBLIC INFORMATION, AND ACCESS TO JUSTICE

Part III then explores the ways and means that public participation, access to information, and access to justice can promote sustainable shale gas development practices. In Chapter 6, 'Public Participation and Sustainability: How Pennsylvania's Shale Gas Program Thwarts Sustainable Outcomes,' Kenneth Kristl addresses what he terms 'the process component of sustainability.' Kristl laments how sustainability goals can become lost when the public is excluded from decision-making about shale gas development and concludes that sustainable outcomes cannot be achieved without meaningful public participation. His case in point is Pennsylvania's recent shale gas legislation (Act 13), which he calls 'a concrete example of how *not* to create a sustainable decision-making process,' because it 'does not foster the kind of public participation necessary to make the program (and hence the policy decision to develop these resources) consistent with sustainability.' To make the process more sustainable, Kristl recommends that the government provide, among other things, better notice, more information, more copious and convenient time frames for public involvement, and ready means to contest improvident decisions.

Jill Morgan continues the discussion of themes supporting public involvement as the *sine qua non* of sustainable shale gas practices, in Chapter 7, 'Sustainability and Stakeholder Participation: Shale Gas Extraction in the United Kingdom.' She contends that greater public involvement in decisions over shale gas development promotes sustainable shale development in general and in the U.K. in particular. She begins by addressing general principles of stakeholder participation in environmental decision-making. Turning to developments in the U.K., she argues that permitting shale gas developers to have access to underground access rights, coupled with the curtailment of requirements

to provide actual notice to affected landowners and tenants, 'have diluted opportunities for landowners and tenants to object to shale gas development' and made shale gas practices less sustainable. These developments, she concludes, 'have reduced rather than fostered opportunities for stakeholder participation, and may well have made it more difficult for the shale gas industry to gain public acceptance.' Consequently, she recommends more public participation and collaboration in decision- and policy-making from the outset, a reversal of the loss of access rights, and re-institution of actual notice. Morgan concludes that the 'Government needs to take a lead in ensuring full transparency of the shale gas industry and its environmental impact, and involving the communities that will have to live with it.'

In Chapter 8, 'Relevance of Transparency to Sustainability and to Pennsylvania's Shale Gas Legislation,' Bernard Goldstein refers to transparency as a 'central characteristic in sustainability,' and highlights the nexus between transparency, health impacts, and sustainable shale gas development. Goldstein maintains that transparency is central to sound environmental management and essential to sustainable practices in shale gas development. He argues that shale gas cannot be developed in a sustainable fashion unless communities have access to information, the right to participate in decision-making, and access to redress for consequences like adverse health impacts.

In particular, Goldstein argues that Pennsylvania's Act 13 thwarts sustainability norms insofar as it permits the identity of chemicals used in injection water as well as the constituents of flowback water to be kept secret, impedes public access to information about hydrofracturing practices, and subjects treating physicians to liability for disclosing what they learn about adverse health impacts of specific chemicals used in hydrofracturing. These, coupled with the state's unwillingness to gather information about human health effects, Goldstein concludes, contribute to three types of 'transparency failures': (1) failure to require disclosure, (2) impeding the public's ability to obtain information about shale gas practices, and (3) what he calls 'intentional blindness.' He also maintains that this transparency gap in shale gas development in Pennsylvania 'has led to a lack of public trust, which contributes to stress and other psychological/social health problems.'

Goldstein advocates for improvements in transparency about the public health effects of shale gas, thereby improving the likelihood of sustainable practices. He recommends disclosure of 'all pertinent information,' more measures to foster public involvement, better deployment of public health surveillance and epidemiology, and measurement of potential community and worker exposures to hazards. Above all, he recommends

that industry and government actively obtain the information needed to respond to public concerns, and place sustainability considerations at the forefront of deliberations about shale gas. This effort should address 'potential trade-offs between environmental, economic and social/health issues, and analysis of the optimum time for development of a limited resource, including appropriate consideration of the end state for the community.'

GOVERNANCE

Part IV then explores governance reforms that might contribute to sustainable practices in shale gas development. Who or what is best situated to regulate shale gas is a core question in framing the connection between shale gas and sustainability. Should the locus of policy-making lie with federal, state, or local governments, or some combination thereof? In Chapter 9, 'Regulating Shale Gas Production for Sustainability: The Federalism Questions,' David Spence finds that a comprehensive federal licensing scheme for shale gas is unnecessary in the United States, 'at least for the time being.' Using a framework of welfare economics, Spence stops short of recommending an allocation of policy-making responsibility between states and local governments in this chapter. Still, he says, policy makers should work to insulate the policy decision process from biases that inhibit the development of a clear picture of the risks of shale gas development, including 'cognitive and cultural biases that make risk regulation difficult.' To guard against such biases one way or the other, Spence recommends that policy makers should: (1) rely on the scientific record instead of averments by pro- or anti-shale gas activists, (2) bear in mind that that the policy debate about shale gas is much broader than the scientific one, (3) have regulators instead of policy makers develop the factual record about shale gas, and (4) avoid prejudgment in policy-making. He concludes that insulating policy from such biases 'is essential if shale gas production is to contribute to sustainability.'

Some countries address sustainability as a constitutional construct. As Jan Glazewski describes in Chapter 10, 'Sustainable Development and Proposed Shale Gas Extraction in South Africa: Prospects and Challenges,' South Africa provides a trenchant vantage for sustainable practices in shale gas development. The country's constitution requires it to undertake 'ecologically sustainable development.' In addition, it has legislation that requires that natural gas be developed 'in an orderly and ecologically sustainable manner while promoting justifiable social and

economic development,' and otherwise 'contribute to sustainable development of South Africa's economy.' Glazewski concludes: 'while South Africa appears committed to a sustainable future on paper … the harsh reality is that its energy security and economic needs are such that these aspirations are overridden by short-term economic development.'

He posits four recommendations to ensure the long-term sustainability of shale gas production in South Africa. First, he recommends that the national government impose a moratorium 'until such time as an adequate legal framework for sustainable shale gas production is put in place. A central question is whether the social needs, in particular the dire need to alleviate poverty, will be met.' Second, he recommends that this moratorium 'continue until an intergovernmental and an independent committee is constituted with robust powers and capacity to apply cooperative governance and environmental management principles in a transparent and coherent manner.' Third, he recommends that the government conduct a comprehensive environmental assessment 'to look at all alternatives and the costs and benefits' of shale gas development. Last, he recommends restraint, suggesting that the government decouple decisions granting licenses to explore from those to develop. This step, he observes, will make it 'clear that the granting of exploration licences does not necessarily mean the automatic grant of a production licence at the end of the exploration phase.'

Then in Chapter 11, 'Sustainable Management of Onshore Recovery of Unconventional Gas in New Zealand,' Trevor Daya-Winterbottom casts a skeptical view as to whether unconventional shale gas development can occur sustainably in New Zealand. He concludes that the regulatory framework in New Zealand is insufficient to promote sustainable development in the context of unconventional shale gas. Daya-Winterbottom first explains how New Zealand regulates unconventional shale gas development, and decries how current legal practices do not distinguish between drilling for water or natural gas. He examines whether and how the public and private sectors are fostering sustainable practices, and queries what is needed to make that happen, concluding that 'sustained regulatory reform will be required in New Zealand over a period of time in order to achieve operational best practices.' Championing reform, he then identifies a 'critical need to provide for a coherent framework' of unconventional gas regulation 'in all regions … to ensure that sustainable management will be achieved.'

ENERGY AND CLIMATE CHANGE

Part V addresses the energy and climate change issues in sustainable shale gas development. In Chapter 12, 'The Sustainability Imperative of the Surprisingly Big Energy Efficiency Resource,' John 'Skip' Laitner challenges the wisdom of choosing sustainable shale gas development over advances in efficiency and conservation. After placing his argument into historical context, Laitner explains that 'energy-efficiency behaviors and investments can drive significantly greater economic, environmental, and social benefits than reliance on either conventional or unconventional energy resources such as shale gas.'

Instead of diving headlong into shale gas development, he instead recommends that 'decision makers change financial incentives (to fossil fuels) and disincentives (to energy efficiency).' He reasons that 'in the larger sustainability context, energy efficiency is likely to be seen as a much better strategy for the ongoing development of the U.S. economy than shale gas production.' Indeed, Laitner calculates that untapped advances in energy efficiency could double the energy potential that would be produced by untapped shale gas production, and also advance sustainability objectives by producing more environmental and job-creation benefits than shale gas production. He writes:

> On balance, the evidence suggests that energy-efficiency behaviors and investments can drive significantly greater economic benefits than reliance on either conventional or unconventional energy resources such as shale gas. Moreover, the evidence suggests that the scale of future energy efficiency gains is likely to be significantly larger than the eventual supply of shale gas resources.

How ethics contributes to climate change and sustainability considerations is the focus of Chapter 13, 'Is Shale Gas Part of a Sustainable Solution to Climate Change? A Factual and Ethical Analysis,' by Donald Brown. Brown debunks claims of the 'climate change benefits of switching from coal to natural gas,' and questions whether shale gas development is an ethical, not to mention a sustainable, pursuit. Brown maintains that social equity – in addition to environmental and economic factors – should inform the sustainability calculus of shale gas development. Brown concludes: 'shale gas cannot be considered sustainable energy unless the United States, Pennsylvania, and other governments adopt policies that ramp up non-fossil fuel as quickly as possible while reducing energy demand aggressively.'

LOOKING FORWARD

In the book's final chapter, Chapter 14, 'Shale Gas and a Sustainable Future,' we synthesize key lessons from all of the book's chapter authors and explain how sustainability informs environmental, health, community, governance, ethical, and climate change outcomes in the context of unconventional shale gas development. We conclude that sustainable shale gas development:

1. requires a sophisticated and comprehensive regulatory system to protect the environment and public health as well as a legal and policy framework capable of ensuring both significant social and economic benefits and ensuring that no one is made socially or economically worse off in absolute terms;
2. must be nested in ambitious national and international energy and climate change laws to ensure that it is a bridge fuel to a sustainable future, and does not delay or divert from that objective; and
3. must occur within a political and legal system that is committed to accelerating the transition to sustainability.

In the United States and elsewhere there is evidence that the first criterion has been met in some ways in some places, as environmental and health outcomes tend to be easier to address. There is less evidence that the latter two criteria have been met. Thus, if shale gas is to accelerate the transition to sustainability, we conclude that transformative changes in law and governance are needed.