THE GLOBAL SHALE GAS INITIATIVE: WILL THE UNITED STATES BE THE ROLE MODEL FOR THE DEVELOPMENT OF SHALE GAS AROUND THE WORLD?

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I. INTRODUCTION

One of the most promising recent developments in the energy sector has been the dramatic increase in the production of natural gas from shale formations, or shale gas.[1] Although experts have known for years about the vast deposits of shale gas found throughout the world, technological difficulties and the high costs of producing shale gas made it impractical to consider as a serious energy source.[2] However, recent technological innovations combining hydraulic fracturing (also

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1. *See Facts about Shale*, AM. PETROLEUM INST., http://www.api.org/policy/exploration/hydraulicfracturing/shale_gas.cfm (last visited Apr. 5, 2011).

2. *See* HALLIBURTON, U.S. SHALE GAS: AN UNCONVENTIONAL RESOURCE, UNCONVENTIONAL CHALLENGES 1 (2008) http://www.halliburton.com/public/solutions/contents/Shale/related_docs/H063771.pdf.

known as "fracing") and horizontal drilling technologies[3] have resulted in a tremendous increase in shale gas production in the United States over the past five years.[4] This boom seems likely to continue with leading energy experts proclaiming shale gas an energy "game changer" that will "revolutionize" global gas markets and help bridge the gap between conventional resources and the development of renewable energy sources.[5]

Thus far, the United States has been the undisputed leader in unlocking the vast tracts of gas-bearing shale found throughout the lower forty-eight states, but Canada is also emerging as a potential major source of shale gas.[6] The so-called "shale gale," the strong wind blown by the technological advances in hydraulic fracturing and horizontal drilling, is not limited to North America.[7] Because shale formations exist in almost every region of the world, the potential for shale gas development is enormous and global in scope.[8]

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3. Hydraulic fracturing technology has been so successful that energy experts have called this the "most significant energy innovation so far of this century." Mary Lashley Barcella & David Hobbs, *Fueling North America's Energy Future*, WALL ST. J., Mar. 10, 2010, at A10.

4. *See Hydraulic Fracturing*, AM. PETROLEUM INST., http://www.api.org/policy/exploration/hydraulicfracturing (last visited Apr. 5, 2011); s*ee also Advanced Drilling Techniques*, AM. PETROLEUM INST., http://www.api.org/aboutoilgas/natgas/drilling_techniques.cfm (last visited Apr. 5, 2011) (explaining "horizontal drilling" techniques).

5. *See* Tom Fowler, Energy *Game-Changer?*, HOUS. CHRON., Nov. 1, 2009, at A1.

6. *See generally Facts about Shale*, *supra* note 1; *see also What is the Current Status of Shale Gas in Canada*?, CAN. SOC'Y FOR UNCONVENTIONAL GAS, http://www.csug.ca/index.php?option=com_content&task=view&id=60&Itemid=66#shale_state (last visited Apr. 5, 2011).

7. Barcella & Hobbs, *supra* note 4, at A10; *see also* Luis E. Cuervo, *OPEC from Myth to Reality*, 30 HOUS. J. INT'L L. 433, 454 (2008) ("The petroleum industry in the 21st century will focus on production of oil and gas from unconventional sources such as heavy oils, tar sands, oil shale, renewables, nuclear power, biomass, and clean coal technologies such as coal liquefaction in a potential transition into a hydrogen based economy.").

8. *See* Leta Smith & Peter Jackson, *Is Unconventional Gas Going Global?*, WALL ST. J., Mar. 10, 2010, at A14, *available at www2.cera.com/ceraweek2010/NAm2010-03-10.pdf*. A new study on global shale gas resources sponsored by the U.S. Energy Information Administration (EIA) reports an initial assessment of 5760 TCF of technically recoverable shale gas resources in 32 foreign countries, compared to 862 TCF in the United States. U.S. ENERGY INFO. ADMIN., WORLD SHALE GAS RESOURCES: AN INITIAL ASSESSMENT OF 14 REGIONS OUTSIDE THE UNITED STATES 2–3 (2011)

Because hydraulic fracturing is an essential part of developing global shale gas resources,[9] it is imperative that the industry ensures the process is safe and environmentally sound before it utilizes the technology in new areas of the world.[10] In the United States, numerous concerns have been raised about the potential environmental impacts of hydraulic fracturing, with a particular focus on the injection of hydraulic fracturing fluids in wells located near drinking water sources,[11] the quantity of water used in the process, and the disposal of waste or flowback water.[12] The U.S. response to these concerns will be closely watched around the world, and a well-crafted regulatory regime could serve as a model for foreign countries looking to responsibly develop their shale gas resources.[13]

So far, Congress has introduced legislation known as the "FRAC Act" that, if passed, will place stricter regulations on the shale gas industry.[14] Additionally, in March of 2010, the U.S. Environmental Protection Agency (EPA) announced that it would conduct a comprehensive research study to investigate the potential adverse impacts that hydraulic fracturing may have on water quality and public health.[15] In the meantime, the

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http://www.eia.gov/analysis/studies/worldshalegas/pdf/fullreport.pdf [hereinafter INITIAL ASSESSMENT].

9. *See* HALLIBURTON, *supra* note 2, at 1; *see also Hydraulic Fracturing*, *supra* note 4.

10. *See* Hannah Wiseman, *Untested Waters: The Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation*, 20 FORDHAM ENVTL. L. REV. 115, 116 (2009).

11. *See generally* ENVTL. PROT. AGENCY, HYDRAULIC FRACTURING RESEARCH STUDY (2010) http://www.epa.gov/safewater/uic/pdfs/hfresearchstudyfs.pdf [hereinafter HYDRAULIC FRACTURING RESEARCH STUDY].

12. *See id.*

13. *See, e.g.*, Adam J. Bailey, Comment, *The Fayetteville Shale Play and the Need to Rethink Environmental Regulation of Oil and Gas Development in Arkansas*, 63 ARK. L. REV. 815, 843 (2010) ("[U]ltimately Arkansas should revamp its system into a model for other states to follow.").

14. *See, e.g.*, S.1215, 111th Cong. (2009); H.R. 2766, 111th Cong. (2009) The FRAC Act did not reach the floor during the 111th Session of Congress and has been re-introduced in the 112th Session of Congress as S. 587, 112th Cong. (2011); H.R. 1084, 112th Cong. (2011).

15. HYDRAULIC FRACTURING RESEARCH STUDY, *supra* note 11.

hydraulic fracturing process continues to draw criticism from environmentalists.[16]

Although the federal regulatory and EPA investigative process will take some time, the United States has nonetheless sought to take the lead in helping other countries find the right balance between energy security and environmental concerns through the Global Shale Gas Initiative (GSGI).[17] The United States launched the GSGI in April 2010 as part of an effort to "promote global energy security and climate security around the world."[18] Recognizing that shale gas has been a "terrific boon" that many countries would want to replicate, the GSGI seeks to share information about the "umbrella of laws and regulations" that exist in the United States.[19] This intricate set of federal and state laws and regulations helps ensure shale gas development is "done safely and efficiently."[20]

To examine whether the GSGI will allow the United States to serve as a role model for the global shale industry, this Article addresses the legal, policy, and environmental challenges associated with shale gas development in the United States. Part I provides an overview of the types of unconventional gas resources, including a discussion of the hydraulic fracturing and horizontal drilling technology that is crucial to shale gas development. Part II highlights the prevailing view that shale gas is an "energy game changer" that could dramatically impact global energy supplies, energy security, climate change mitigation, and geopolitics. This section also provides an overview of the major shale gas basins in the United States and Canada and a brief discussion of the potential shale gas reserves in the rest of the world.

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16. Christoper Swann, *Shale Gas Needs to Allay Environmental Doubts*, N.Y. TIMES, Mar. 7, 2011, at B2.

17. David L. Goldwyn, Special Envoy for Int'l Energy Affairs, U.S. Dep't of State, Briefing on the Global Shale Gas Initiative Conference (Aug. 24, 2010), *available at* http://www.state.gov/s/ciea/rmk/146249.htm [hereinafter Briefing on GSGI Conference]; *see also* David L. Goldwyn, *Global Shale Gas Initiative: Balancing Energy, Security, and Environmental Concerns*, DIPNOTE (Sept. 3, 2010), http://blogs.state.gov/index.php/site [hereinafter *GSGI: Balancing Concerns*].

18. Briefing on GSGI Conference, *supra* note 17.

19. Briefing on GSGI Conference, *supra* note 17.

20. *Id.*

Part III discusses the GSGI as well as other U.S. efforts and initiatives to help countries around the world develop their own shale gas resources. Part IV addresses the various environmental concerns that have been raised related to the development of shale gas in the United States. Part V discusses the federal and state laws and regulations affecting shale gas development in the United States, including an analysis of proposed legislation to further regulate the industry and a recent EPA study into the potential impact of hydraulic fracturing on drinking water sources and other environmental effects.

Finally, Part VI concludes that a careful analysis of the legal, policy, and environmental challenges associated with global shale gas development needs to be done before the full potential of this game-changing resource can be realized. With the exploration of shale gas resources being undertaken on nearly every continent, will the United States lead the way as a role model for environmental best practices in other countries? Though it may be too soon to tell, it is certainly a development worth watching.

II. OVERVIEW OF UNCONVENTIONAL GAS DEVELOPMENT AND TECHNOLOGY

A basic understanding of the different types of gas reservoirs is helpful in order to appreciate the difficulties involved in extracting natural gas from certain types of reservoirs.

A. Types of Natural Gas Reservoirs

In general, gas reservoirs are classified as conventional or unconventional based on the following:[21]

Conventional reservoirs: In a conventional reservoir, natural gas has migrated from a source rock into a "trap" that is capped by an impermeable layer of rock.[22] Conventional gas

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21. GROUND WATER PROT. COUNCIL & ALL CONSULTING, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER 15 (2009) http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/Shale_Gas_Primer_2009.pdf [hereinafter MODERN SHALE GAS].

22. *See* JACQUELINE LANG WEAVER, TEXAS OIL AND GAS LAW: CASES AND MATERIAL

reservoirs are often associated with deposits of oil and are often developed in conjunction with oil.[23] In conventional gas reservoirs, a traditional well may simply be drilled directly into the reservoir.[24] Because the sands or rock that contain the gas have interconnected pore spaces, and are thus permeable in nature, the gas flows naturally to the wellbore.[25]

Unconventional reservoirs: In an unconventional reservoir, natural gas must be extracted from the source rock itself using a variety of production techniques including hydraulic fracturing and horizontal drilling.[26] Because of the low permeability of unconventional reservoirs, these techniques are used to stimulate the reservoir—by creating fissures in the rock, the gas flows more easily through it, enhancing production.[27] There are three types of unconventional gas reservoirs:

1–7 (2009) (discussing conventional geology and methodology of oil and gas production).

23. *See id.*

24. *See id.*

25. *See id.*

26. *See* MODERN SHALE GAS, *supra* note 21, at 15.

27. *Id*; *see Hydraulic Fracturing*, *supra* note 4; *see also* CHESAPEAKE ENERGY, HYDRAULIC FRACTURING FACT SHEET 1 (2010), http://www.chk.com/Media/CorpMediaKits/Hydraulic_Fracturing_Fact_Sheet.pdf [hereinafter HYDRAULIC FRACTURING FACT SHEET].

1. **Tight Gas:** Tight gas commonly refers to natural gas that is trapped in sandstones, and it accounts for approximately 30% of current U.S. natural gas production.[28]

2. **Coal Bed Methane (CBM):** CBM is natural gas that is produced from coal seams, which act as the source and reservoir for the natural gas.[29] CBM has been produced commercially since the 1980s and today accounts for approximately 8% of total U.S. natural gas supply.[30]

3. **Shale Gas: "**Shale gas is natural gas produced from shale formations that typically function as both the reservoir and source for the natural gas."[31] The economic potential of a particular shale formation can be evaluated by indentifying specific source rock characteristics.[32] These characteristics are used to predict whether marketable volumes will be produced from the formation.[33] A number of wells may need to be drilled and analyzed in order to sufficiently determine the potential of the shale formation, especially if the basin is large and the targeted zones varied.[34] This article focuses on shale gas as opposed to the other two types of unconventional gas because of the significant growth in shale gas production in recent years.

B. Hydraulic Fracturing and Horizontal Drilling

The primary method of natural gas extraction from unconventional sources involves the combination of two production technologies—hydraulic fracturing and horizontal drilling.[35] Although these two technologies have been around for

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28. Enerdynamics, *The Rise of Unconventional Gas*, THE ENERGY INSIDER, Sept. 18, 2007, at 4.

29. MODERN SHALE GAS, *supra* note 21, at 15.

30. Dr. Romeo Flores, *Coalbed Methane: Gas of the Past, Present and Future,* SCITOPICS, Nov. 5, 2008, http://www.scitopics.com/Coalbed_Methane_Gas_of_the_Past_Present_and_Future.html.

31. MODERN SHALE GAS, *supra* note 21, at 14.

32. *Id.* at 16.

33. *Id.*

34. *Id.*

35. *See* Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W. 3d 1, 6

decades, the combination of the two, coupled with technological advances in equipment and cost reductions, was the key to unlocking the vast reserves of shale gas in North America.[36]

Hydraulic fracturing involves the high-pressure injection of fluids into a natural gas formation to create fissures in the rock.[37] This process allows the natural gas to move freely from the rock pores so it can be pumped to the surface.[38] Horizontal drilling has been instrumental in increasing production volumes from all forms of natural gas and oil wells and is used extensively in shale gas production.[39] Horizontal drilling involves drilling a vertical well to the desired depth and then drilling laterally to access a larger portion of the reservoir.[40] Once the targeted area is reached, hydraulic fracturing is then used to help produce the gas reservoir.

(Tex. 2008) (Texas Supreme Court describing the fracing process); *see also* HYDRAULIC FRACTURING FACT SHEET, *supra* note 27.

36. *See Annual Energy Outlook 2010*, U.S. ENERGY INFO. ADMIN. (2010), http://www.eia.doe.gov/oiaf/aeo/pdf/trend_4.pdf.

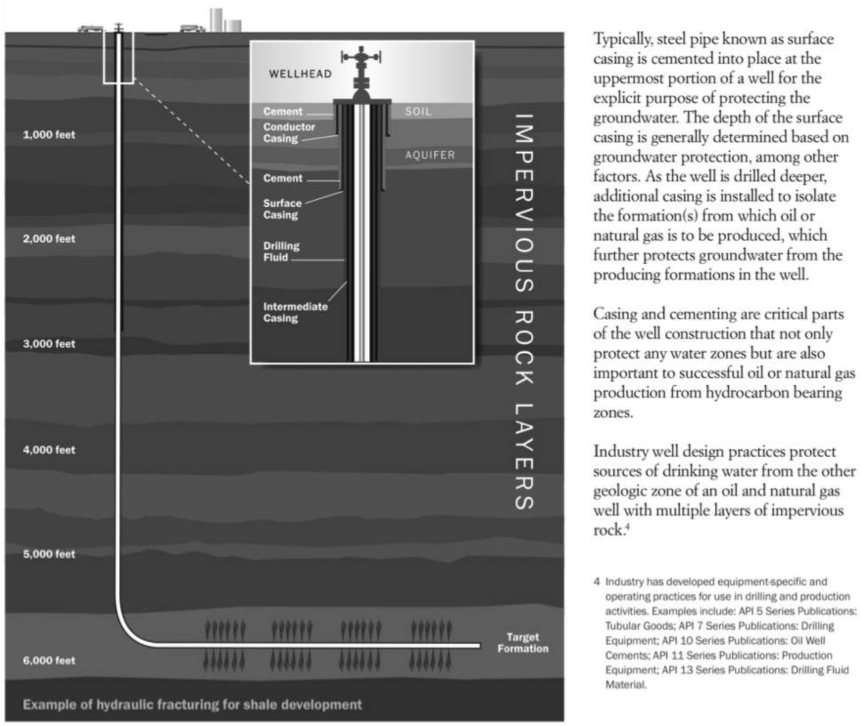
37. AM. PETROLEUM INST., FREEING UP ENERGY, HYDRAULIC FRACTURING: UNLOCKING AMERICA'S NATURAL GAS RESOURCES 5 (2010), http://www.api.org/policy/exploration/hydraulicfracturing/upload/HYDRAULIC_FRACTURING_PRIMER.pdf [hereinafter FREEING UP ENERGY].

38. *Id.*

39. MODERN SHALE GAS, *supra* note 21, at ES-3.

40. *See Advanced Drilling Techniques*, *supra* note 4.

Figure 1: Typical horizontal well used for shale development[41]



C. Hydraulic Fracturing Fluids

A key component to hydraulic fracturing is the high-pressure injection of hydraulic fracturing fluids[42] that increases the permeability of the rock by "propping up" or holding open the fractures.[43]

According to the industry, fracturing fluid is a mixture of about 90% water, 9.5% sand, and 0.5% other chemicals.[44]

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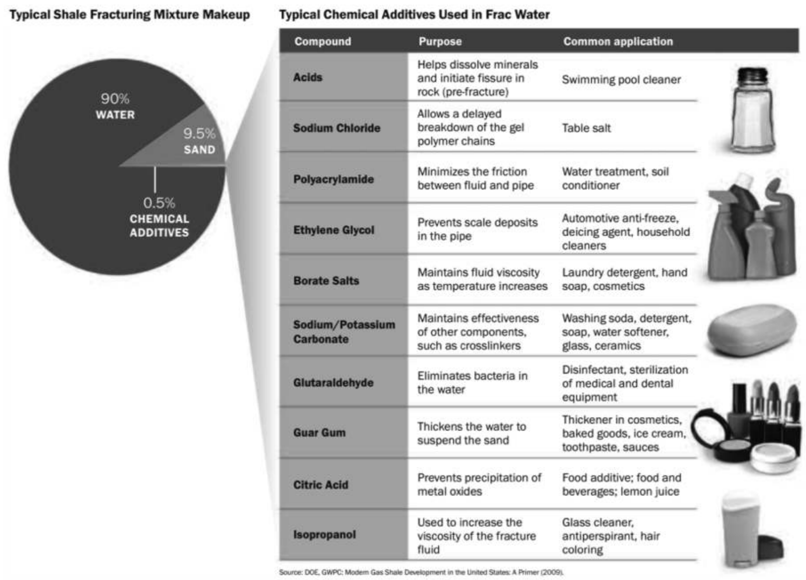
41. FREEING UP ENERGY, *supra* note 37, at 7.

42. *See* HYDRAULIC FRACTURING FACT SHEET, *supra* note 27; *see also* ENVTL. PROT. AGENCY, EVALUATION OF IMPACTS TO UNDERGROUND SOURCES OF DRINKING WATER BY HYDRAULIC FRACTURING OF COALBED METHANE RESERVOIRS STUDY, at 4-1 (2004) , http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_coalbedmethanestudy.cfm [hereinafter DRINKING WATER IMPACT STUDY].

43. *Id.*

44. FREEING UP ENERGY, *supra* note 37, at 8.

Figure 2: Typical shale fracturing fluid makeup and chemicals[45]



The hydraulic fracturing of shale gas wells is performed in numerous stages, with each stage using a series of different volumes and compositions of fracturing fluids.[46] A typical shale gas well may involve four or more stages that use millions of gallons of water-based fracturing fluids mixed with a variety of proppant materials and chemical additives.[47]

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45. *Id.*
46. MODERN SHALE GAS, *supra* note 21, at 58.
47. *Id.* at 60–61,

Table 1: Estimated per-well water needs for four U.S. shale gas plays[48]

Shale Gas Play	Volume of Drilling Water per well (gal)	Volume of Fracturing Water per well (gal)	Total Volumes of Water per well (gal)
Barnett Shale	400,000	2,300,000	2,700,000
Fayetteville Shale	60,000*	2,900,000	3,060,000
Haynesville Shale	1,000,000	2,700,000	3,700,000
Marcellus Shale	80,000*	3,800,000	3,880,000

* Drilling performed with an air "mist" and/or water-based or oil-based muds for deep horizontal well completions.
Note: These volumes are approximate and may vary substantially between wells.
Source: ALL Consulting from discussions with various operators, 2008

Although water is the main component of hydraulic fracturing fluids, a number of additives and chemicals are also used, and the number and type of additives used varies based on the conditions of the specific well being fractured.[49] The additives used include common, everyday chemicals as well as potentially hazardous chemicals that are safe when properly handled.[50]

III. SHALE GAS: THE GLOBAL ENERGY "GAME CHANGER"

Over the past decade, natural gas production from unconventional gas resources has significantly increased,,with production from shale gas formations rising almost 65% from 2007 to 2008 alone.[51] The rapid development of North American shale gas has dramatically transformed the global gas markets and led many experts to proclaim shale gas an energy "game-changer."[52]

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48. *Id.* at 64.

49. Id. At 61.

50. *Id* at 62,

51. *Natural Gas Supply—Resources*, AM. CLEAN SKIES FOUND., http://www.cleanskies.org/resources-supply.html (last visited Apr. 5, 2011).

52. Press Release, Int'l Energy Agency, 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 (Nov. 10, 2009), *available at* http://www.iea.org/

The game-changing nature of shale gas is due to both increased production and significant increases in the estimated natural gas resource base.[53] An influential study done in 2008 estimated that North America has 2247 TCF of natural gas resources, the equivalent of 118 years of U.S. production.[54] In June 2009, the Potential Gas Committee established by the University of Colorado School of Mines estimated the U.S. natural gas resource base at 1836 TCF, the highest estimate ever released by that group.[55]

A. *Shale Gas Development and Resources in the United States*

The production of shale gas is expanding particularly rapidly in the United States.[56] According to the U.S. Energy Information Administration (EIA), during the last decade U.S. shale gas production increased eight-fold and now accounts for ten percent of U.S. gas production and twenty percent of total remaining recoverable gas resources in the United States.[57] According to the EIA, shale gas represents the largest source of growth in the U.S. natural gas production for the coming decades.[58]

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press/pressdetail.asp?PRESS_REL_ID=294; *see also* Amy Myers Jaffe, *Shale Gas Will Rock the* World, WALL ST. J., May 10, 2010, http://online.wsj.com/article/SB10001424052702303491304575187880596301668.html; Fowler, *supra* note 5.

53. *See generally* NAVIGANT CONSULTING, INC., THE DYNAMICS OF ABUNDANCE OF NORTH AMERICAN NATURAL GAS SUPPLY (2009) http://www.usaee.org/usaee2009/submissions/presentations/Pickering.pdf.

54. *Id.* at 2.

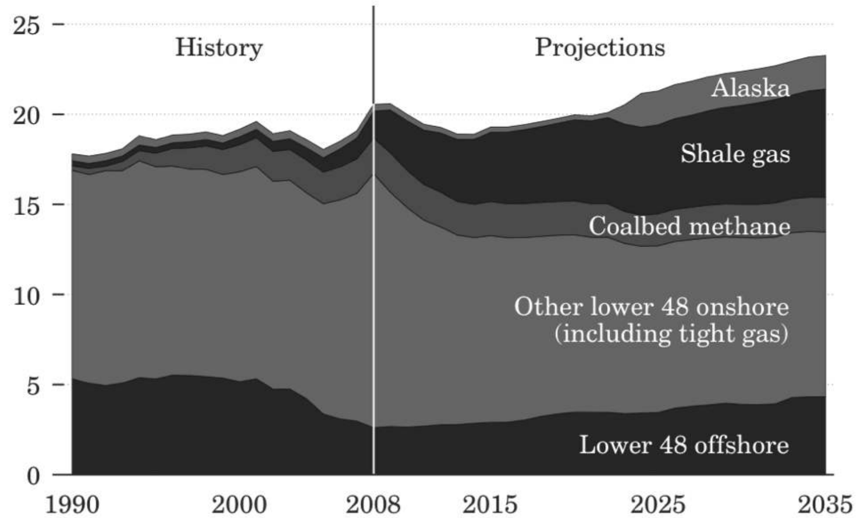
55. Colo. School of Mines, News Release, Potential Gas Committee Reports Unprecedented Increase in Magnitude of U.S. Natural Gas Resource Base (June 18, 2009), *available at* http://www.mines.edu/Potential-Gas-Committee-reports-unprecedented-increase-in-magnitude-of-U.S.-natural-gas-resource-base.

56. *Global Shale Gas Initiative (GSGI)*, U.S. DEP'T OF STATE, http://www.state.gov/s/ciea/gsgi/index.htm (last visited Apr. 5, 2011).

57. *Id.*

58. *See infra* Figure 3.

Figure 3: Natural gas production by source, 1990–2035 (TCF)[59]



In the United States, shale gas exists in most of the lower forty-eight states.[60] The most active shale basins to date are the Barnett Shale, the Haynesville/Bossier Shale, the Antrim Shale, the Fayetteville Shale, the Marcellus Shale, and the New Albany Shale.[61] Because each of these gas shale basins is different, "the development of shale gas resources in each of these areas faces potentially unique opportunities and challenges."[62]

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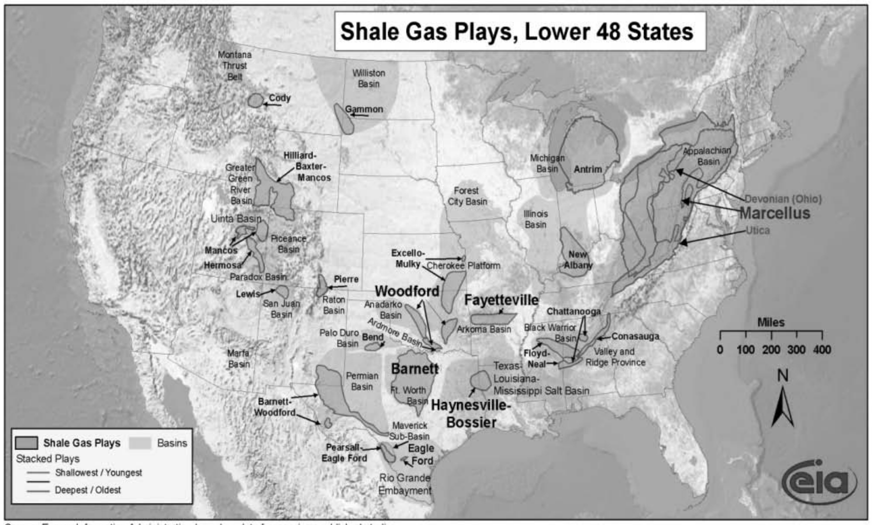
59. U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2010, 72 Figure 73 (2010), *available at* http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2010).pdf.

60. *Infra* Figure 4.

61. MODERN SHALE GAS, *supra* note 21, at ES-2.

62. *Id.*

Figure 4: Map of U.S. Shale Basins[63]



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

Overview of Major U.S. Shale Plays

The Barnett Shale is located in the Fort Worth Basin of north central Texas and was the first major shale play in the United States.[64] The success of the Barnett Shale grabbed the industry's attention. As the home of more than 10,000 wells, its record as one the busiest shale gas plays in the United States is undisputed.[65] As one of the first of the modern shale plays, it was the testing grounds for proving that the combined technologies of hydraulic fracturing and horizontal drilling could lead to the successful and economical development of shale gas.[66] Because this play is starting to mature "natural gas producers have been looking to extrapolate the lessons learned

63. *See generally Shale Gas Plays, Lower 48 States*, U.S. ENERGY INFO. ADMIN., http://www.eia.doe.gov/oil_gas/rpd/shale_gas.pdf (last visited Apr. 5, 2011) (depicting the U.S. Shale Basins).

64. MODERN SHALE GAS, *supra* note 21, at 13, 18.

65. *Id.*

66. *Id.* at 13.

in the Barnett to the other shale gas formations present across the [United States] and Canada."[67]

The development of the Fayetteville Shale, which is situated in the Arkoma Basin of northern Arkansas and eastern Oklahoma, began in the early 2000s.[68] Companies who had reaped the success of the Barnett Shale were looking forward to applying the same techniques to similar formations, or new shale plays.[69] These companies quickly recognized the parallels between the Barnett and Fayetteville Shale—similar age of the formation and geologic character. Lessons learned from the horizontal drilling and hydraulic fracturing techniques employed in the Barnett assisted in the commercial viability of the Fayetteville Shale[70] where more than 1000 wells now exist.[71]

The Haynesville/Bossier shale play is mainly found in North Louisiana but also touches parts of East Texas.[72] Although there has already been exploratory drilling and testing for several years, "the full extent of the play will only be known after several more years of development are completed."[73]

The Marcellus Shale is "the most expansive shale gas play.[74]" This play covers six states in the northeastern United States, including New York and Pennsylvania, an area of 95,000 square miles.[75] Range Resources Corporation was the first company to drill economically producing wells in the Marcellus formation. Their success is attributable to their use of horizontal drilling and hydraulic fracturing techniques, the same techniques used in the Barnett Shale in Texas.[76]

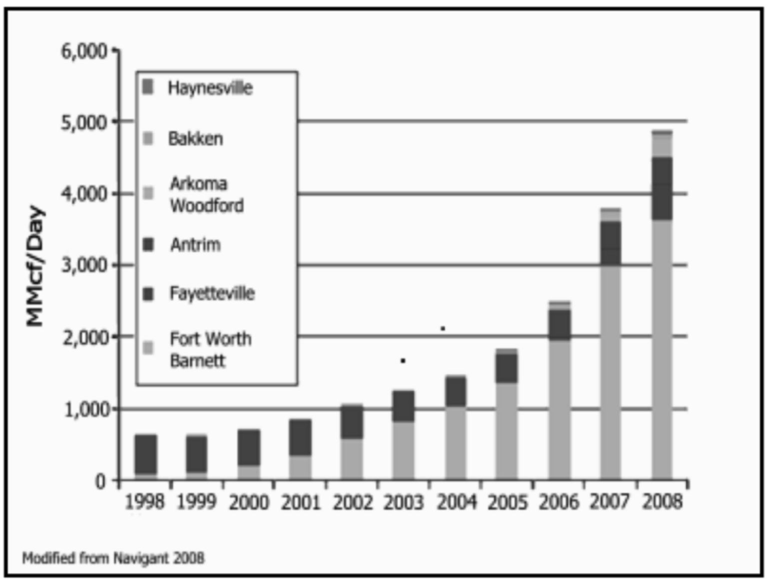
67. *Id.*
68. *Id.* at 19.
69. *Id.*
70. *Id.*
71. *Id.*
72. *Id.* at 20.
73. *Id.*
74. *Id.* at 21.
75. *Id.*
76. *Id.*

The Woodford Shale is located in south central Oklahoma and is at "an early stage of development."[77]

The Antrim Shale is in the Michigan Basin.[78] Next to the Barnett Shale, "the Antrim Shale has been one of the most actively developed shale gas plays."[79] Most of its expansion took place in the late 1980s.[80] As opposed to other gas shale plays in the United States, the Antrim has a shallow depth, and "small stratisgraphic thickness."[81]

Another major shale play is the New Albany Shale located in the Illinois Basin and covering portions of Illinios, Indiana and Kentucky.[82] This play encompasses an area of approximately 43,500 square miles.[83]

Figure 5: Daily production from each of the currently active shale gas plays[84]



77. *Id.* at 22.
78. *Id.* at 23.
79. *Id.*
80. *Id.*
81. *Id.*
82. *Id.* at 24.
83. *Id.*
84. *Id.* at 10 fig.9.

B. Shale Gas Development and Resources in Canada

Canada has significant petroleum, natural gas, and coal reserves,[85] is one of only three member-states of the Organization for Economic Cooperation and Development (OECD) that is a net energy exporter.[86] Canada is the largest source of U.S. energy imports, and nearly all of Canada's oil and gas exports go to the United States.[87] Recognizing the importance of energy trade, both the U.S. and Canada along with Mexico, participate in the North American Energy Working Group, which seeks to improve energy integration and cooperation between the countries in the region.[88]

Although Canada is a major producer of conventional natural gas, in recent years, the country has increasingly focused on developing natural gas from unconventional resources such as shale gas.[89] This is largely due to the view that production of conventional gas has peaked and new gas finds are needed to offset the decline.[90]

The Canadian gas industry is currently undergoing a transformation similar to that of the United States through its increased focus on shale gas production.[91] The most significant shale basins are located in northeastern British Columbia, while

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85. Martin Ferguson, Austl. Minister for Res. and Energy and Minister for Tourism, Australia's Energy and Resources Future (June 23, 2010) *available at* http://minister.ret.gov.au/MediaCentre/Speeches/Pages/Australia%27sEnergyandResourcesFuture.aspx.

86. *Id.* Australia and Norway are the other two net energy exporters.

87. *Country Analysis Briefs: Canada*, ENERGY INFO. ADMIN., http://www.eia.doe.gov/emeu/cabs/Canada/Background.html (last visited Apr. 5, 2011) [hereinafter *Country Analysis Briefs: Canada*].

88. *North American Energy Working Group (NAEWG)*, U.S. DEP'T OF ENERGY, http://www.pi.energy.gov/naewg.htm (last visited Apr. 5, 2011) (The North American Energy Working Group (NAEWG) was established in 2001 by the U.S. Secretary of Energy, the Secretary of Energy of Mexico, and the Canadian Minister of Natural Resources).

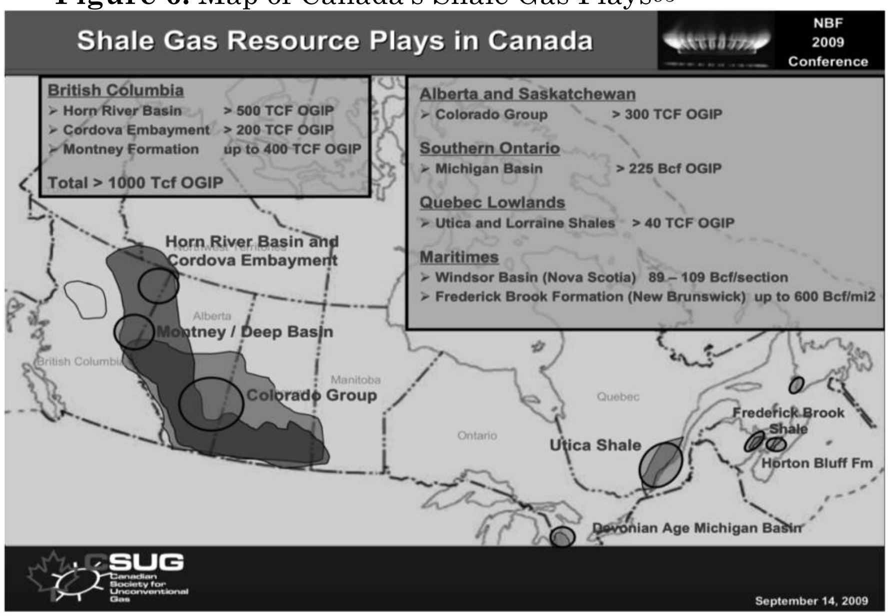
89. *Unconventional Gas Facts*, CAN. SOC'Y FOR UNCONVENTIONAL GAS, http://www.csug.ca/index.php?option=com_content&task=view&id=60&Itemid=66 (last visited Apr. 5, 2011).

90. *Id.*

91. *See* Gary Park, *Gas Revolution No. 2: Canadian Shale*, PIPELINE & GAS J., May 2010, *available at* http://pipelineandgasjournal.com/gas-revolution-no-2-canadian-shale?page=show.

some shale basins in Alberta, Ontario, Quebec, and the Maritimes also have some potential.[92] Although large-scale commercial production of shale gas has not yet occurred in Canada, this might change in the coming years.[93] More than $2 billion has been invested in northeast British Columbia to establish land positions in the Horn River Basin and the Montney Trend.[94]

Figure 6: Map of Canada's Shale Gas Plays[95]



92. *See Unconventional Gas Facts*, *supra* note 90.

93. *Shale Gas*, CAN. SOC'Y FOR UNCONVENTIONAL GAS, http://www.csug.ca/index.php?option=com_content&task=view&id=60&Itemid=66#shale (last visited Apr. 5, 2011).

94. *Id.*

95. Michael Dawson, President, Can. Soc'y for Unconventional Gas, Lecture at the Developing Natural Gas Conference: Shale Gas Plays in Canada: Opportunities from Coast to Coast (Apr. 7, 2009), *available at* http://www.csug.ca/images/CSUG_presentations/2009/Hart_energy_conf_Presentation_final.pdf.

In terms of the potential resource base of Canadian natural resources, estimates show a dramatic increase in Canada's natural gas reserve potential and put Canada's natural gas in place (GIP) at almost 4000 TCF.[96] Such a dramatic increase in the reserve estimates results from the large contribution unconventional gas resources makes to the reserves, dramatically changing the picture of Canada's gas potential.[97]

Table 2: Canada's Gas in Place Resources (TCF)[98]

Conventional (GIP)	692
Natural Gas from Coal/Coalbed Methane	801
Tight Gas	1311
Shale Gas	1111
Total	**3915**

The marketable portion is between 700 and 1300 TCF of which 357 TCF are conventional and between 376 (low case) and 947 TCF (high case) are unconventional.[99] This estimate is significantly higher than prior estimates that did not include potential unconventional resources, but it may still underestimate the true value of Canada's gas reserves.[100] A lack of available data on some emerging shale gas plays resulted in those plays being excluded from the total.[101] This additional natural gas will likely play a major role in shaping Canada's long-term natural gas supply.[102]

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96. F. M. DAWSON, CROSS CANADA CHECK UP: UNCONVENTIONAL GAS EMERGING OPPORTUNITIES AND STATUS OF ACTIVITY 3 (2010), http://www.csug.ca/images/Technical_Luncheons/Presentations/2010/MDawson_AGM2010.pdf [hereinafter CROSS-CANADA CHECK UP]

97. *See id.*

98. *See id.*

99. Paul Wells, *CSUG Report Pegs Canada's Natural Gas in Place at Almost 4,000 tcf*, OIL & GAS INQUIRER, June 2010, *available at* http://www.oilandgasinquirer.com/printer.asp?article=profiler%2F100610%2FPRO2010_UA0002.html.

100. *Id.*

101. *See id.*

102. *See* CROSS-CANADA CHECK UP, *supra* note 97, at 3.

Table 3: Canada's Estimated Marketable Gas Resources (TCF)[103]

Conventional (Remaining GIP)	357
Natural Gas from Coal/Coalbed Methane	34–129
Tight Gas	215–476
Shale Gas	128–343
Total	**733–1304**

C. Shale Gas Development and Resources in the Rest of the World

The shale gas "revolution" that is transforming the North American natural gas market is not just limited to that region.[104] It has been widely recognized that there is enormous unconventional gas potential in other parts of the world.[105] As in the United States, shale gas appears to be the most promising type of unconventional gas that may be developed around the world, followed by tight gas and CBM.[106] There are many challenges to the development of all three types of unconventional gas outside the United States, but the primary challenge so far is estimating the potential resource base.[107] According to the International Energy Agency (IEA), there are only limited studies estimating global unconventional gas resources and "major work is still needed to refine and expand [the] data."[108] With few exceptions, unconventional gas resources around the world have "largely been overlooked and understudied" and most "have not been appraised in any systematic way."[109]

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103. *See* CROSS-CANADA CHECK UP, *supra* note 97, at 6–10.

104. Smith & Jackson, *supra* note 8.

105. *Id.*

106. *Id.*

107. *See* INT'L ENERGY AGENCY, MEDIUM-TERM OIL & GAS MARKETS 185 (2010) [hereinafter MTOGM].

108. *Id.*

109. *Id.* at 186.

In terms of existing regional estimates of global unconventional gas potential, Asia Pacific and North America have the highest, "with 274 TCM and 233 TCM respectively followed by [the former Soviet Union] with 155 TCM, Latin America [with] 98 TCM and [the Middle East–North Africa region with] 95 TCM."[110] Though significant attention has been devoted to Europe's potential unconventional gas resources, so far, they are estimated at only 35 TCM.[111] The IEA notes that "shale gas represents half of this global potential and is especially present in Asia and North America while CBM is mainly in [the former Soviet Union] and tight gas is quite evenly distributed between the regions."[112] The agency indicates these numbers "should be considered with caution" as not all of this gas will be recoverable.[113]

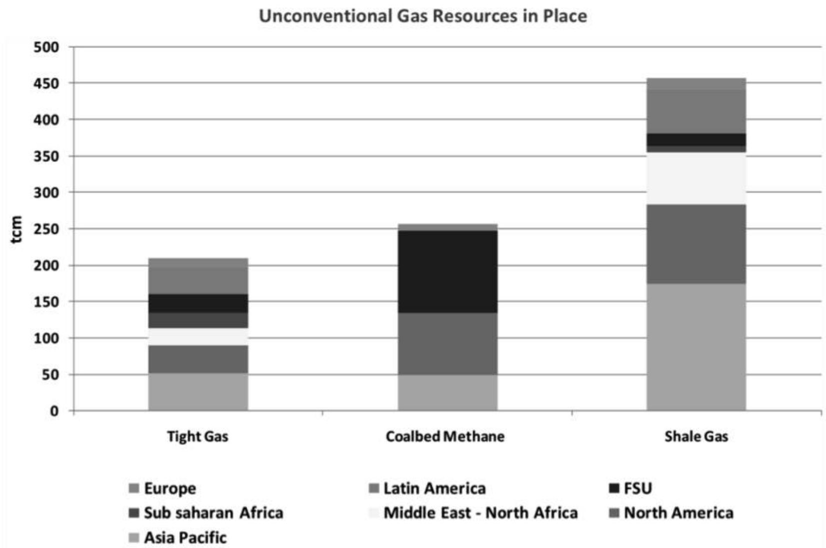
110. *Id.* at 185; *see* Susan L. Sakmar, Recent Development, *The Status of the Draft Iraq Oil and Gas Law*; 30 HOUS. J. INT'L L. 289, 295 n.35 (2008) (noting Iraq's "fairly significant gas reserves").

111. MTOGM, *supra* note 108, at 185.

112. *Id.*

113. *Id.* The IEA has estimated that "around 380 [TCM] would be recoverable based on current data and knowledge." *Id.* at 186.

Figure 7: Worldwide Unconventional Gas Resources in Place[114]



Source: World Energy Outlook 2009, IEA.

In terms of country-specific developments, Australia ranks first among the countries able to develop its unconventional gas resources in the short-term.[115] CBM has been at the "mature market stage in Australia for some time, but shale gas is still in its infancy."[116]

China has potentially significant unconventional gas resources and has expressed considerable interest in developing these.[117] Historically China's focus has been on CBM, but recently its focus has shifted towards developing its shale gas resources.[118] Although these are estimated at 26 TCM, the country has never appraised its shale gas reserves but is expected to do so in the near future.[119] China's Ministry of Land

114. *Id.* at 185.
115. *Id.* at 187.
116. *Id.* at 188.
117. *Id.*
118. See i*d.*
119. *Id.* at 188–89.

and Resources (MLR) "has announced a strategic goal of reaching a production target of 15–30 BCM (billion cubic meters) by 2020."[120] It will be critical for China to acquire technology to meet these production goals.[121] China's Sinopec has already engaged in dialogue with international oil companies in furtherance of this goal.[122] In November 2009, China and the United States signed a Memorandum of Understanding to jointly cooperate in assessing China's shale gas resources and, consequently, promote investments in this area.[123]

Similar to China, India has historically focused on CBM but is now turning to shale gas, which is rapidly gaining the attention of industry players.[124] In April 2010, India's Reliance Industries Ltd. invested $1.7 billion in the U.S. Marcellus shale play.[125] This was viewed as an indication that Indian companies are looking to acquire expertise and technology to develop shale gas resources, both at home and abroad.[126] The two major obstacles for India are a lack of clarity regarding upstream regulation for shale gas and a lack of data as most of India's shale gas potential remains underexplored.[127]

Compared to Australia and India, Indonesia has been slow to develop its unconventional gas resources, and foreign companies have been reluctant to invest there largely because of the legal and regulatory uncertainty.[128] Indonesia's outlook may change, however, in light of its estimated shale gas potential of approximately 30 TCM and its plans to launch a tender of shale gas fields.[129]

Europe has received the most industry attention because many countries in the region are looking to replicate the U.S.

120. *Id.* at 189.
121. *Id.*
122. *Id.*
123. *Id.* at 188.
124. *Id.* at 189.
125. *Id.*
126. *Id.*
127. *Id.*
128. *Id.* at 190.
129. *Id.*

shale gas revolution.[130] While there are "many challenges that could prevent an unconventional gas boom happening in Europe," recently, there has been a lot of activity and interest in shale gas in Austria, Bulgaria, France, Germany, Italy, Poland, Romania, Spain, Sweden, and the United Kingdom.[131] International oil companies, which were largely absent from early shale gas development in the United States have been more proactive in Europe.[132] Many major oil companies, including ExxonMobil, Shell, Chevron, ConocoPhillips marathon, and Total are present in one or more European countries.[133]

Figure 8: Unconventional Gas Activities in Europe[134]

Unconventional Gas Activities in Europe

	CBM	Tight gas	Shale
Austria			OMV
Belgium	European Gas, Transcor Astra Group		
Bulgaria	CBM Energy		
France	European Gas Ltd		Total, Egdon Resources, Mouvoil, Schueppbach Energy LLC, Dale Gas Partners, Eagle Energy Ltd, Bridgeoil Ltd., Diamoco Energy
Germany	Exxon Mobil	Wintershall	ExxonMobil,
Hungary		MOL, Falcon, Exxon Mobil	Exxon Mobil
Italy	Ind. Resources plc		
Poland	Composite Energy, EurEnergy	Aurelian	ExxonMobil, ConocoPhilips, Lane Energy, Talisman, Chevron, Aurelian, FX Energy
		FX Energy	
Romania	Falcon, Galaxy		Aurelian, FX Energy
Sweden			Shell
UK	Island gas, Composite Energy		
	BG, Nexen, Marathon		
Turkey			TransAtlantic Petroleum, TPAO

Preliminary work, exploration, assessment of seismic data
Wells drilled
Production

Note: the list of companies is not exhaustive.
Source: IEA, based on press releases, news reports.

130. *Id.*
131. *Id.*
132. *Id.*
133. *Id.* at 190–91.
134. *Id.* at 191.

In most European countries, most of these developments are at the very early stages and seismic data is just barely being compiled.[135] The IEA notes that "only a few European countries are actually producing unconventional gas, and then only in small quantities."[136] Of these, Poland is worth noting as shale gas has received significant attention in that country.[137] In its report, the IEA also points "Poland has approved approximately 45 exploration licenses for shale gas[, and] ExxonMobil has five concessions in the Podlasie and Lublin basins representing 1.3 million acres."[138]

According to estimates by Wood Mackenzie, an oil and gas research group, Poland's unconventional gas reserves could be as high as 48 TCF.[139] If confirmed, this would significantly increase "the European Union's proven reserves of natural gas and . . . make Poland, which imports 72 per cent of its gas, self-sufficient for the foreseeable future."[140] Significant shale gas production in Poland could also alter the gas geopolitics for the entire European region, which has historically been dependent on Russian supplies of natural gas.[141] In light of this, there "is a land grab under way"[142] in Poland with several major energy companies investing in nascent shale gas industry including Chevron, ConocoPhillips, and Canadian-based Talisman.[143]

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135. *Id.* at 190.

136. *Id.*

137. *Id.* at 191.

138. *Id.*

139. Robin Pagnamenta, *Dash for Poland's Gas Could End Russian Stranglehold on Supplies*, TIMES (London), Apr. 5, 2010, at 33.

140. *Id.*

141. *See id.*; *see also* Kim Talus, *Access to Gas Markets: A Comparative Study on Access to LNG Terminals in the European Union and the United States*, 31 HOUS. J. INT'L L. 343, 354 (2009).

142. Pagnamenta, *supra* note 140 (quoting Oisin Fanning, executive chairman of San Leon Energy, a British company that has secured three license areas in Poland); *see also* Dinakar Sethuraman, *Exxon, Chevron 'Land Grab' for Europe Shale Gas, JP Morgan Says*, BLOOMBERG BUSINESSWEEK, Feb. 11, 2010, *available at* http://www.businessweek.com/news/2010-02-11/exxon-chevron-land-grab-for-europe-shale-gas-jpmorgan-says.html.

143. MTOGM, *supra* note 108, at 191.

France, Germany, and Hungary are also just emerging as potential shale gas players while other countries are starting to assess their potential reserves.[144] The IEA notes that "many initiatives are underway such as the Gas Shales in Europe ('GASH'), coordinated by the German GeoForschungsZentrum (GFZ) and The Institut Français du Pétrole (IFP). In other regions, [international oil companies (IOCs)] and National Oil Companies (NOCs) have been carrying out exploratory work [on unconventional resources,]" yet the results remain to be seen.[145]

D. Challenges to Developing Global Shale Gas

The IEA has recognized that there are numerous challenges to replicating the success of the U.S. shale gas revolution overseas.[146] There are several issues raised by the IEA that may impact the development of global unconventional gas resources.[147] They include:

1. Limited studies on unconventional gas potential around the world,
2. Environmental concerns,
3. Fiscal conditions,
4. Landowner acceptance,
5. Interference from local authorities,
6. Pipeline and infrastructure issues,
7. Availability of technology, equipment and skilled labor force, and
8. Gas players' experience.[148]

Of these, environmental concerns and landowner acceptance are worth noting since these two areas have been the most challenging in the development of shale gas in the U.S.[149] Environmental concerns, which are discussed in further detail

144. *See generally id.* at 192.
145. *Id.* at 186.
146. *See id.* at 184–85.
147. *Id.*
148. *Id.*
149. *See id.* at 186–87.

in Part IV below, span a wide range of issues from water usage to water pollution to intellectual property violations.[150]

In terms of landowner acceptance, this is likely to vary depending on whether the landowner stands to gain financially from the drilling activity.[151] In the United States, landowners often stand to benefit financially from drilling on their property—if they own the underground resources, they may receive a bonus or royalties upon leasing to an oil company in order to develop the resources.[152] For example, some U.S. landowners who own the underground mineral resources have received "up to $25,000 per acre, and sometimes up to 25% royalty" by leasing their property for shale gas development.[153] Although this financial incentive has been particularly helpful in the development of shale gas in the United States, it may not be as relevant in other areas of the world where landowners do not own the underground resources.[154]

The IEA also notes the numerous environmental concerns that have been raised in the United States.[155] These concerns include the impact hydraulic fracturing might have on local water supplies in terms of potential contamination of underground drinking water sources and surface waters as well as issues related to the quantity of water used in the process.[156] These issues are discussed in detail below in Part IV.

IV. THE GSGI: WILL THE UNITED STATES BE A MODEL FOR GLOBAL SHALE GAS DEVELOPMENT?

In recognition of the growing worldwide interest in developing unconventional gas resources, in April 2010, the U.S. Department of State launched the GSGI "in order to help countries seeking to utilize their unconventional natural gas resources to identify and develop them safely and

150. *Id.*
151. *Id.*
152. *See id.* at 187.
153. *Id.*
154. *See id.*
155. *See id.* at 186–87.
156. *See id.*

economically"[157] and in an "environmentally sensitive manner."[158] The goal of the GSGI is to assist countries seeking to develop their own unconventional gas resources with balancing energy security and environmental concerns.[159]

A country's ability to participate on the initiative depends largely on the "presence of gas-bearing shales within their borders, market potential, business climates, geopolitical synergies, and host government interest."[160] Countries have been classified into tiers with Tier 1 countries being those that "have the greatest potential for benefiting from GSGI opportunities" and Tier 2 countries are those "that have expressed interest and meet GSGI criteria."[161] So far, partnerships have been arranged with China, India, and Poland.[162]

In August of 2010, when the first meeting of the GSGI took place, the representatives of seventeen different countries discussed "the importance of shale gas as a lower-carbon fuel option that can help reduce CO2 emissions while ensuring energy security and economic development in the 21st century."[163] The meeting was a "regulatory conference" designed to showcase the "umbrella of laws and regulations [in the United States] that makes sure [shale gas development] is done safely and efficiently."[164]

At the conference, the State Department noted that the United States has both federal and state laws to protect land

157. *Polish Delegation Attends First Multilateral Meeting of the Global Shale Gas Initiative*, U.S. DIPLOMATIC MISSION TO WARSAW, POLAND (Aug. 24, 2010), http://poland.usembassy.gov/shalegas.html.

158. *GSGI: Balancing Concerns*, *supra* note 17. *See generally* Briefing on GSGI Conference, *supra* note 17.

159. *Id.*

160. *Polish Delegation Attends First Multilateral Meeting of the Global Shale Gas Initiative*, *supra* note 158.

161. *Id.*

162. *Id.*

163. *Id.*; *see also* J. Scott Childs, *Continental Cap-and-Trade: Canada, the United States, and Climate Change Partnership in North America*, 32 HOUS. J. INT'L L. 393, 418–19 (2010) (noting that a "conversion to natural gas" has contributed to lower emissions).

164. Briefing on GSGI Conference, *supra* note 17.

use, water, and air as well as the capacity to monitor, regulate and enforce the laws.[165] The conference gave U.S. agencies, such as the EPA and the EIA, the opportunity to explain the laws and regulations pertaining to shale gas development in the United States, with particular attention was paid to issues pertaining to water protection since water is scarce in many countries.[166]

Whether the GSGI can provide a regulatory model for environmental best practices is debatable and remains to be seen.[167] In light of the growing environmental challenges and the potential for further regulation facing the U.S. shale gas industry, the usefulness of the U.S. legal scheme as a model framework is still an open question, especially as it relates to environmental issues.[168] As discussed in detail below, there is some indication that production may have outpaced the ability of some states to effectively oversee the safety and environmental sustainability of shale gas development.[169] If the United States is having difficulty with the safety and environmental aspects of shale gas drilling, how can other countries keep pace with shale gas developments? This question is especially critical for those countries with less-developed laws and regulations.[170] At the same time, it is possible that the GSGI might help resolve some of these issues.[171] Either way, it seems evident that the United States is committed to staying

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165. *Id.*

166. *Id.*

167. To date, there has been limited activity related to the GSGI, and it remains to be seen whether this initiative gains in prominence.

168. *See* MTOGM, *supra* note 108, at 186–87; *see also* Amy Westervelt, *Shale Gas Booming Globally, Despite Chemical Dangers*, SOLVE CLIMATE NEWS (Aug. 9, 2010), http://solveclimatenews.com/news/20100809/shale-gas-booming-globally-despite-chemical-dangers.

169. *Infra* Parts IV, V.; *see* ANTHONY ANDREWS ET AL., UNCONVENTIONAL GAS SHALES: DEVELOPMENT, TECHNOLOGY, AND POLICY ISSUES 33–38 (2009) http://www.fas.org/sgp/crs/misc/R40894.pdf.

170. *See* Laura C. Reeder, Note, *Creating a Legal framework for Regulation of Natural Gas Extraction from the Marcellus Shale Formation*, 34 WM. & MARY ENVTL. L. & POL'Y REV. 999, 1022 (2010) (describing the complex legal obstacles inherent to shale gas development)

171. *See GSGI: Balancing Concerns*, *supra* note 17 (explaining that the GSGI could minimize legal complications by helping foreign governments design unique regulatory frameworks *before* allowing any shale gas development).

involved in one of the most significant developments in the energy world this decade.[172]

V. ENVIRONMENTAL ISSUES ASSOCIATED WITH SHALE GAS DEVELOPMENT IN THE UNITED STATES

The development of shale gas in the United States has been widely recognized as one of the most promising trends in U.S. both in terms of job creation and economic benefits as well as its resulting increase in the domestic supplies of natural gas.[173] Many people view natural gas as a cleaner-burning fossil fuel that could enhance energy independence, reduce emissions and serve as a bridge fuel to renewable energy.[174]

Though there are many proponents of shale gas, there are also many who oppose it because of the technology necessary to produce it.[175] This opposition has intensified as hydraulic fracturing has become more commonplace in wells around the country and around the world.[176] Horizontal drilling does not face much opposition because it actually reduces surface disturbance.[177] For its part, the gas industry contends that

172. *See, e.g.*, INITIAL ASSESSMENT, *supra* note 8, at 5.

173. *See, e.g.*, Bailey, *supra* note 13, at 844 ("The Fayetteville Shale is important to the economy and commerce of Arkansas, and natural-gas production is included in many plans for reducing American dependence on foreign oil and is a transitional framework to alternative energy.") (internal citation omitted).

174. *See GSGI: Balancing Concerns*, *supra* note 17; *see also* Jessie S. Lotay, *Subprime Carbon: Fashioning an Appropriate Regulatory and Legislative Response to the Emerging U.S. Carbon Market to Avoid a Repeat of History in Carbon Structured Finance and Derivative Instruments*, 32 HOUS. J. INT'L L. 459, 487 (2010).

175. *See, e.g.*, Wes Deweese, *Fracturing Misconceptions: A History of Effective State Regulation, Groundwater Protection, and the Ill-Conceived FRAC Act*, 6 OKLA. J. L. & TECH. 49, 6 (2010).

176. *See* Westervelt, *supra* note 169. As shale goes global, concerns have been raised in other countries as well. *See e.g.*, Monique Beau Din, *Shale-gas Opposition is Growing, Survey Concludes*, THE GAZETTE (Montreal), Feb. 16, 2011, at A6; *Exploration Ban in France Extended*, CALGARY HERALD (Can.), Jan. 20, 2011, at B4.

177. Phillip E. Norvell, *Prelude to the Future of Shale Gas Development: Well Spacing and Integration for the Fayetteville Shale in Arkansas*, 49 WASHBURN L.J. 457, 458 ("Horizontal wells also offer the opportunity to reduce the environmental footprint of surface-producing operations. One surface well location can support several subsurface horizontal laterals and, therefore, avoid multiple surface well locations, access roads, and gathering-pipeline locations.") (internal citation omitted).

hydraulic fracturing is safe, well-regulated, and has a proven track record having been used in the United States since the 1940s in drilling more than one million wells.[178]

In support of the safety of hydraulic fracturing, the industry often points to a 2004 EPA study that assessed the potential for contamination of underground sources of drinking water from the injection of hydraulic fracturing fluids into CBM wells.[179] In that study, the EPA concluded that the injection of hydraulic fracturing fluids into these wells posed "little or no threat to [underground drinking water]."[180] After reviewing incidents of drinking water well contamination, the EPA found "no confirmed cases that are linked to fracturing fluid injection into coalbed methane wells or subsequent underground movement of fracturing fluids."[181]

The industry also maintains that the continued use of hydraulic fracturing is critically important to producing the natural gas America will need in the future.[182] It is estimated that "[80%] of natural gas wells drilled in the next decade will require hydraulic fracturing"[183] and that without it, the United States could lose "[45%] of domestic natural gas production." [184]

A. Water Contamination Concerns

Despite the industry's claims that hydraulic fracturing is a safe and proven technology, environmental organizations, public health groups, and local communities have expressed numerous concerns about the potential environmental impacts of the use of hydraulic fracturing around the country.[185] There have been

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178. FREEING UP ENERGY, *supra* note 37.

179. *See id.*

180. DRINKING WATER IMPACT STUDY, *supra* note 42, at 7–5.

181. *Id.* at 7–6.

182. *Hydraulic Fracturing*, *supra* note 4.

183. *Id.*

184. API Global Insight, Measuring the Economic and Energy Impacts of Proposals to Regulate Hydraulic Fracturing: Task 1 Report 2 (2009) http://www.api.org/Newsroom/upload/IHS_GI_Hydraulic_Fracturing_Task1.pdf.

185. *See* Amy Mall, *Incidents Where Hydraulic Fracturing is a Suspected Cause of Drinking Water Contamination*, SWITCHBOARD: NAT'L RES. DEF. COUNCIL STAFF BLOG (Oct. 4, 2010), http://switchboard.nrdc.org/blogs/amall/incidents_where_hydraulic_frac.html (listing incidents of drinking water contamination and supporting regulation of

many allegations that hydraulic fracturing has led to the contamination of drinking water in many communities.[186] This has led to increased calls for federal regulation of hydraulic fracturing under the Safe Drinking Water Act (SDWA) that would provide a minimum federal floor for drinking water protection in the states engaged in drilling shale gas.[187]

The nonprofit, investigative journalism organization, ProPublica, has an extensive investigation of hydraulic fracturing underway.[188] According to that investigation, numerous states have reported cases involving spills of hazardous materials or other occurrences of water contaminated by oil or gas operations.[189] There are also hundreds of cases of water contamination in drilling areas where hydraulic fracturing is used, including some pending lawsuits alleging contamination.[190]

ProPublica has also noted the difficulty scientists face in specifically determining "which aspect of drilling—the hydraulic fracturing, the waste water that accidentally flows into the ground, the leaky pits of drilling fluids or the spills from truckloads of chemicals transported to and from the site—causes [the reported] pollution."[191]

One challenge has been the refusal by the industry to make public the chemical makeup of the hydraulic fracturing fluid

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hydraulic fracturing under the Safe Drinking Water Act).

186. *Id.*

187. *Id.*

188. *See Buried Secrets: Gas Drilling's Environmental Threat*, PROPUBLICA, http://www.propublica.org/series/buried-secrets-gas-drillings-environmental-threat (last visited Apr. 5, 2011) (containing links to various investigative pieces concerning the environmental impact of gas drilling). In the Drilling Down series of articles, the New York Times is also examining the risks of shale gas drilling and efforts to regulate the rapidly growing industry. *Drilling Down*, N.Y. Times, http://topics.nytimes.com/top/news/us/series/drilling_down/index.html (last visited Apr. 5, 2011).

189. Abraham Lustgarten, *Setting the Record Straight on Hydraulic Fracturing*, PROPUBLICA, Jan. 12, 2009, http://www.propublica.org/article/setting-the-record-straight-on-hydraulic-fracturing-090112 [hereinafter *Setting the Record Straight on Hydraulic Fracturing*].

190. *Id.*; Abraham Lustgarten, *Pa. Residents Sue Gas Driller for Contamination, Health Concerns*, PROPUBLICA, Nov. 20, 2009, http://www.propublica.org/article/pa-residents-sue-gas-driller-for-contamination-health-concerns-1120.

191. *Setting the Record Straight on Hydraulic Fracturing*, *supra* note 190.

used on a particular well.[192] Without this information, "environmental officials say they cannot conclude with certainty when or how certain chemicals entered the water."[193]

B. Water Quantity and Flowback Concerns

Concerns have also been raised pertaining to the large volumes of water needed during the hydraulic fracturing process, and the disposal of the flowback or wastewater from fracturing operations.[194] A recent U.S. Geological Survey (USGS) report noted these concerns in a report dealing with water resources and gas production in the Marcellus Shale.[195] According to the USGS report, "many regional and local water management agencies [in the Marcellus shale region] are concerned about where such large volumes of water will be obtained, and what the possible consequences might be for local water supplies."[196]

Chesapeake Energy Corp., one of the most active drillers in the Marcellus shale,[197] candidly admits water is an essential component of its deep shale gas development.[198] According to the company, "fracturing a typical Chesapeake Marcellus horizontal deep shale gas well requires an average of five and a half million gallons per well."[199] Chesapeake also maintains that water resources are protected through stringent state, regional and local permitting processes and in comparison to other uses

192. *Id.*

193. *Id.*

194. ANDREWS ET AL., *supra* note 170, at 1.

195. DANIEL J. SOEDER & WILLIAM M. KAPPEL, WATER RESOURCES AND NATURAL GAS PRODUCTION FROM THE MARCELLUS SHALE 3–4 (2009) http://pubs.usgs.gov/fs/2009/3032/pdf/FS2009-3032.pdf.

196. *Id.* at 4.

197. Press Release, Chesapeake Energy, Chesapeake Energy Corporation Confirms Decision Not to Drill for Natural Gas in the New York City Watershed (Oct. 28, 2009) available at *http://www.chk.com/news/articles/pages/1347788.aspx.*

198. *Fact Sheet: Water Use in Marcellus Deep Shale Gas Exploration*, CHESAPEAKE ENERGY (2010), http://www.chk.com/media/marcellusmediakits/marcellus_water_use_fact_sheet.pdf [hereinafter CHESAPEAKE ENERGY, *Water Use*].

199. *Id.*

within the area, deep shale gas drilling and fracturing uses a small amount of water.[200]

Hydraulic fracturing also gives rise to concerns pertaining to the disposal of wastewater.[201] While some of the injected hydraulic fracturing fluids remain trapped underground, the majority—60–80% returns to the surface as "flowback."[202] The USGS has noted that because the quantity of fluids is so large, the additives in a 3 million gallon job would yield about 15,000 gallons of chemicals in the flowback water.[203] Some states, such as West Virginia, have noted that wastewater disposal is "perhaps the greatest challenge" in hydraulic fracturing operations.[204]

Other shale producing areas face the same challenges. In north Texas, increased water use stemming from a growing population, drought, and the Barnett Shale development has led to heightened concerns about water availability.[205] In January 2007, the Texas Water Development Board (TWDB) published a study of a nineteen-county area in North Texas that contains estimates of water used in the Barnett Shale development.[206] The TWDB report indicates that the fracturing of a horizontal well completion can use more than 3.5 million gallons (more than 83,000 barrels) of water.[207] In addition, the wells may be re-fractured multiple times when the natural gas flow slows after being in production for several years.[208] However, the report estimates that the amount of water used for development has been a relatively small percentage of the total water use.[209]

200. *Id.*

201. *See* DRINKING WATER IMPACT STUDY, *supra* note 42, at 3–11.

202. *Id.*

203. SOEDER & KAPPEL, *supra* note 196, at 4.

204. ANDREWS ET AL., *supra* note 170, at 35.

205. JAMES E. BENÉ & ROBERT HARDEN, NORTHERN TRINITY/WOODBINE GROUNDWATER AVAILABILITY MODEL: ASSESSMENT OF GROUNDWATER USE IN THE NORTHERN TRINITY AQUIFER DUE TO URBAN GROWTH AND BARNETT SHALE DEVELOPMENT 1 (2007), http://rio.twdb.state.tx.us/RWPG/rpgm_rpts/0604830613_BarnetShale.pdf.

206. *Id.*

207. *Id.* at 14.

208. *Id.* at 2-44.

209. *Id.* at 2–3.

Although growing, the report calculated water used for the Barnett Shale accounted for only three percent of the total groundwater used.[210]

The TWDB report makes predictions of future water needs for the area, including Barnett Shale development.[211] These estimate an increase in the groundwater used from three percent in 2005 to seven to thirteen percent in 2025.[212]

C. The EXXON/XTO Merger

The Exxon/XTO merger was made against the backdrop of increased interest and scrutiny in developing U.S. shale gas resources.[213] In December 2009, ExxonMobil (Exxon) announced plans to buy XTO Energy (XTO) in an all-stock transaction worth about $41 billion (including debt of $10 billion), which would create the largest U.S. natural gas producer and holder of gas reserves.[214]

Exxon's interest in XTO was driven primarily by XTO's strong unconventional gas resource base and its technical expertise in extracting shale gas through hydraulic fracturing technology.[215]

The Exxon/XTO merger was seen by many in the oil and gas industry as a show of confidence in the future of shale gas.[216] Many praised the deal as a boost for shale gas to play a greater role in supplying the world with abundant, affordable, and cleaner-burning energy.[217]

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210. *Id.*

211. *Id.*

212. *Id.* at 3.

213. *ExxonMobil to Boost Unconventional Focus by Acquiring XTO*, OIL & GAS J., Dec. 21, 2009, at 31; *see Natural Gas Helps Exxon and Shell Lift Profits*, N.Y. TIMES, July 30, 2010, at B4.

214. *ExxonMobil to Boost Unconventional Focus by Acquiring XTO*, *supra* note 214.

215. *The ExxonMobil-XTO Merger: Impact on U.S. Energy Markets: Hearing Before the Subcomm. on Energy and Env't of the H. Comm. on Energy and Commerce*, 111th Cong. 53 (2010) (statement of Rex Tillerson, CEO, ExxonMobil Corp.), *available at* http://energycommerce.house.gov/Press_111/20100120/transcript_01202010_ee.pdf.

216. Katie Howell, *House Panel Looks into Effects of Exxon-XTO Merger*, N.Y. TIMES, Jan. 19, 2010, http://www.nytimes.com/gwire/2010/01/19/19greenwire-house-panel-looks-into-effects-of-exxon-xto-me-96870.html.

217. *Id.*

At the same time, the proposed merger led to greater scrutiny of the hydraulic fracturing technology, which has drawn intense criticism from environmentalists and lawmakers concerned about the potential impact of hydraulic fracturing on water supplies and the environment.[218]

At the congressional hearings related to the merger, several lawmakers expressed concern that the proposed merger would reduce competition in the oil and gas industry and also lead to an increase in the use of hydraulic fracturing and horizontal drilling.[219] Other lawmakers expressed concern that the technologies could pollute drinking water supplies.[220]

Exxon Chairman Rex Tillerson defended the controversial hydraulic fracturing technology and assured lawmakers that, "[w]ith recent advances in extended reach horizontal drilling, combined with the time-tested technology of hydraulic fracturing . . . we can now find and produce unconventional natural supplies miles below the surface in a safe, efficient and environmentally responsible manner."[221] Mr. Tillerson also indicated that continued use of hydraulic fracturing was essential for the industry and the merger.[222] Indeed, the continued use of hydraulic fracturing was so important to the combined company's success that the merger agreement provided an "opt out" provision allowing the deal to be called off if any event or action gave rise to a "Company Material Adverse Effect," which included changes in laws that made hydraulic fracturing illegal or commercially impracticable.[223]

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218. *Id.*

219. Tom Doggett, *Exxon-XTO Merger Draws Scrutiny from Congress*, REUTERS, Jan. 20, 2010, *available at* http://www.reuters.com/article/idUSTRE60J53920100120.

220. *Id.*

221. *Id.*

222. *Id.*

223. XTO ENERGY INC., AGREEMENT AND PLAN OF MERGER, DATED AS OF DEC. 13, 2009-DEC. 15, 2009, art. I, IX, *available at* http://www.faqs.org/sec-filings/091215/XTO-ENERGY-INC_8-K/dex21.htm; *see also* Russell Gold, *Exxon Can Stop Deal if Drilling Method Is Restricted*, WALL ST. J., Dec. 17, 2009, at B3.

The XOM/XTO merger closed on June 25, 2010 without any congressional or regulatory action to limit or ban hydraulic fracturing.[224]

VI. REGULATORY FRAMEWORK FOR SHALE GAS DEVELOPMENT IN THE UNITED STATES

As described above, hydraulic fracturing is a water intensive technology that raises many issues related to the environmental protection of U.S. water supplies.[225] The gas industry believes that existing state regulations are adequate to protect water resources during the development of shale gas resources.[226] This view is also shared by the Ground Water Protection Council (GWPC), which represents state groundwater protection agencies and underground injection control (UIC) program administrators.[227] However, there is a growing contingent of landowners, environmental groups and citizen groups calling for federal regulation and further investigation of hydraulic fracturing due to concerns about water usage and possible contamination.[228] Though an analysis of individual existing state laws is beyond the scope of this article,[229] there are several

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224. *ExxonMobil Announces Completion of All-Stock Transaction for XTO*, BUSINESS WIRE, June 25, 2010, *available at* http://www.businesswire.com/portal/site/exxonmobil/index.jsp?ndmViewId=news_view&ndmConfigId=1001106&newsId=20100625005806&newsLang=en; *see also* Anna Driver, *Exxon Sees Greater Scrutiny After BP Spill*, REUTERS, July 08, 2010, *available at* http://www.reuters.com/article/idUSN0821129720100708?rpc=21.

225. *Supra* Part IV.

226. HYDRAULIC FRACTURING FACT SHEET, *supra* note 27; *see* Hannah Wiseman, *Regulatory Adaptation in Fractured Appalachia*, 21 VILL. ENVTL. L. J. 229, 288–89 (2010); *see also Hydraulic Fracturing*, *supra* note 4 (outlining industry practices relating to hydraulic fracturing).

227. HYDRAULIC FRACTURING FACT SHEET, *supra* note 27; *About Us*, GROUND WATER PROT. COUNCIL, http://www.gwpc.org/about_us/about_us.htm (last visited Apr. 5, 2011).

228. *See* Mireya Navarro, *8,000 People? E.P.A. Defers Hearing on Fracking*, GREEN: A BLOG ABOUT ENERGY & THE ENV'T (Aug. 10, 2010, 5:28 p.m.), http://green.blogs.nytimes.com/2010/08/8000.people-e-p-a-defers-hearing-on-fracking; *see also* Mike Soraghan, *BP, Others Push Against Federal Regulation of Fracturing*, N.Y. TIMES, Mar. 23, 2010, *available at* http://www.nytimes.com/gwire/2010/03/23/23greenwire-bp-others-push-against-federal-regulation-of-f-95671.html.

229. *See generally* THOMAS E. KURTH, ET AL., LAW APPLICABLE TO HYDRAULIC FRACTURING IN THE SHALE STATES (2010) http://www.haynesboone.com/files/Publication/

important federal regulations that are relevant and discussed in detail below.

A. *The Safe Drinking Water Act*

The SDWA[230] is the primary federal law for protecting public water supplies from harmful contaminants.[231] Enacted in 1974,[232] and broadly amended in 1986 and 1996,[233] the SDWA is administered through a variety of programs that regulate contaminants in public water supplies, provide funding for infrastructure projects, protect underground sources of drinking water, and promote the capacity of water systems to comply with SDWA regulations.[234]

The EPA is the federal agency responsible for administering the SDWA[235] but a federal–state structure exists in which the EPA may delegate primary enforcement and implementation authority (primacy) for the drinking water program to states and tribes.[236] The state-administered Public Water Supply Supervision (PWSS) program remains the basic program for regulating public water systems,[237] and the EPA has delegated primacy for this program to all states, except Wyoming and the District of Columbia (which SDWA defines as a state).[238] The

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13b38836-cf13-44fa-b781-f366943021fa/Presentation/PublicationAttachment/fea83e1a-3d59-4fb6-88fe-8caf7138979f/FRAC_Report.pdf.

230. Safe Drinking Water Act, 42. U.S.C. § 300f (2005).

231. *Safe Drinking Water Act*, OFFICE OF WATER, ENVTL. PROT. AGENCY, http://water.epa.gov/lawsregs/rulesregs/sdwa/index.cfm (last visited Apr. 5, 2011).

232. *Id.*

233. *Id.*

234. *See generally* ENVTL. PROT. AGENCY OFFICE OF WATER, UNDERSTANDING THE SAFE DRINKING WATER ACT (2004), http://water.epa.gov/lawsregs/guidance/sdwa/upload/2009_08_28_sdwa_fs_30ann_sdwa_web.pdf [hereinafter UNDERSTANDING THE SAFE DRINKING WATER ACT].

235. *Id.*

236. *See id.*

237. *Public Water System Supervision (PWSS) Grant Program*, OFFICE OF WATER, ENVTL. PROT. AGENCY, http://water.epa.gov/grants_funding/pws/index.cfm (last visited Apr. 5, 2011).

238. UNDERSTANDING THE SAFE DRINKING WATER ACT, *supra* note 235.

EPA has responsibility for implementing the PWSS program in these two jurisdictions and throughout most Indian lands.[239]

A second key component of the SDWA requires the EPA to regulate the underground injection of fluids to protect underground sources of drinking water.[240] In terms of oil and gas drilling, the UIC program regulations specify siting, construction, operation, closure, financial responsibility, and other requirements for owners and operators of injection wells.[241] Thirty-three states (including West Virginia, Ohio, and Texas) have assumed primacy for the UIC program.[242] The EPA has lead implementation and enforcement authority in ten states, including New York and Pennsylvania, and authority is shared in the remainder of the states.[243]

Notwithstanding the SDWA's general mandate to control the underground injection of fluids to protect underground sources of drinking water, the law specifically states that EPA regulations for state UIC programs "may not prescribe requirements which interfere with or impede . . . any underground injection for the secondary or tertiary recovery of oil or natural gas, unless such requirements are essential to assure that underground sources of drinking water will not be endangered by such injection."[244] Consequently, the EPA has not regulated gas production wells, and historically had not considered hydraulic fracturing to fall within the regulatory definition of underground injection until relatively recently.[245]

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239. *See id.*

240. ANDREWS ET AL., *supra* note 170, at 37.

241. *Id.* (noting that requirements for Class II wells are found in 40 C.F.R. §§ 144–46).

242. *Id.*

243. *See id.* To receive primacy, a state must demonstrate to the EPA that its UIC program is at least as stringent as the federal standards. *Id.* For Class II wells, states must demonstrate that their programs are effective in preventing pollution of underground sources of drinking water. *Id.* at 37 n.77.

244. Safe Drinking Water Act, 42 U.S.C. § 300h(b)(2) (2005).

245. ANDREWS ET AL., *supra* note 170, at 37.

B. Leaf v. EPA

Until 1997, it was unclear whether hydraulic fracturing was regulated under the UIC programs.[246] However, the U.S. Court of Appeals for the 11th Circuit ruled that the hydraulic fracturing of coal beds for methane production constituted underground injection that must be regulated.[247] Since this decision applied only in the 11th Circuit, the only state required to revise its UIC program was Alabama.[248]

In response to the decision in *Leaf v. EPA*[249] and citizen complaints about water contamination attributed to hydraulic fracturing, the EPA began to study the impacts of hydraulic fracturing practices used in CBM production on drinking water sources, and to determine whether further regulation was needed.[250] In 2004, the EPA issued a final (phase I) report, based primarily on interviews and a review of the available literature, and concluded that the injection of hydraulic fracturing fluids into CBM wells posed little threat to underground sources of drinking water and required no further study.[251]

The EPA noted, however, that very little documented research had been done on the environmental impacts of injecting fracturing fluids.[252] It also noted that estimating the concentration of diesel fuel components and other fracturing fluids beyond the point of injection was beyond the scope of its

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246. Deweese, *supra* note 176, at 10.

247. Legal Envtl. Assistance Found. v. Envtl. Prot. Agency, 118 F.3d 1467, 1477 (11th Cir. 1997).

248. *Id.* In 2000, a second suit was filed against the EPA wherein the court approved Alabama's revised UIC program, despite several alleged deficiencies. Legal Envtl. Assistance Found. v. Envtl. Prot. Agency, 276 F.3d 1253, 1256 (11th Cir. 2001). The U.S. Court of Appeals for the 11th Circuit directed the EPA to require Alabama to regulate hydraulic fracturing under the SDWA. *Id.* at 1477–78. The court determined that the EPA could regulate hydraulic fracturing under the SDWA's more flexible state oil and gas provisions in section 1425, rather than the more stringent underground injection control requirements of section 1422. *Id.* at 1260–61.

249. Legal Envtl. Assistance Found. v. Envtl. Prot. Agency, 118 F.3d 1467 (11th Cir. 1997).

250. DRINKING WATER IMPACT STUDY, *supra* note 42, at ES-1.

251. *Id.*

252. *Id.* at 4-1.

study.[253] Some members of Congress and some EPA professional staff criticized the report, asserting that its findings were not scientifically founded.[254]

Ultimately, in the Energy Policy Act of 2005[255], Congress amended SDWA Section 1421 to specify that the definition of "underground injection" excludes the injection of fluids or propping agents (other than diesel fuels) used in hydraulic fracturing operations related to oil, gas, or geothermal production activities.[256] This exclusionary language effectively removed the EPA's (unexercised) authority under SDWA to regulate the underground injection of fluids for hydraulic fracturing purposes.[257] Environmentalists and others opposed to hydraulic fracturing commonly refer to this exclusionary language as "The Halliburton Loophole," based on a New York Times editorial of the same title.[258]

C. The FRAC Act

As shale gas development spread across the United States, so too did public concern about the safety and environmental impact of hydraulic fracturing. These concerns ultimately made their way to Congress where companion bills H.R. 2766 and S. 1215 were introduced in 2009 an effort to amend the SDWA to include hydraulic fracturing.[259]

Representative Diana DeGette introduced H.R. 2766 on June 9, 2009 and Senator Robert Casey Jr. introduced S. 1215 as the "Fracturing Responsibility and Awareness of Chemicals Act"—or "FRAC Act").[260] The FRAC Act would amend the

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253. *Id.* at 4-12.

254. Mike Soraghan, *Natural Gas Drillers Protest Nomination of Fracking Critics for EPA Review Panel*, N.Y. TIMES, Sept. 30, 2010, *available at* http://www.nytimes.com/gwire/2010/09/30/30greenwire-natural-gas-drillers-protest-nomination-of-fra-98647.html.

255. Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (2005).

256. Id. § 322.

257. *See* Safe Drinking Water Act § 1421, 42 U.S.C. § 300h.

258. *See The Halliburton Loophole*, Editorial, N.Y. TIMES, Nov. 3, 2009, at A28.

259. Fracturing Responsibility and Awareness of Chemicals Act of 2009, S. Con. Res. 1215, 111th Cong. (2009); Fracturing Responsibility and Awareness of Chemicals (FRAC) Act, H.R. Con. Res. 2766, 111th Cong. (2009).

260. S. 1215; H.R. 2766.

SDWA definition of "underground injection" to expressly include "the underground injection of fluids or propping agents" used for hydraulic fracturing in oil and gas operation and production activities.[261] The bills would also require public disclosure of the chemical constituents (but not the proprietary chemical formulas) used in the fracturing process.[262] As of October 23, 2010, H.R. 2766 had sixty-nine co-sponsors but ultimately the FRAC Act did not reach the house floor before the 111th Congress recessed.[263] The FRAC Act has recently been re-introduced in the 112th Congress.[264]

D. EPA Study

In December 2009, six months after the introduction of the FRAC Act 2009, the U.S. House of Representatives Appropriation Conference Committee recommended that a focused study was needed analyzing the relationship between hydraulic fracturing and drinking water.[265] The committee believed the EPA should conduct this study.[266] The EPA agreed with Congress that a study was warranted due to the serious environmental and health concerns that had been raised from citizens living in the vicinity of shale gas production areas employing hydraulic fracturing technology.[267]

In addition to examining the potential relationships between hydraulic fracturing and drinking water, a key goal of the EPA study is to generate data and information that can be used to

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261. S. 1215 § 2(a); H.R. 2766 § 2(a).

262. S. 1215 § 2(b).; H.R. 2766 § 2(b).

263. Bill Summary and Status, H.R. 2766, 111th Congress (2009), The Library of Congress, Thomas, http://thomas.loc.gov/cgi-bin, (follow "Bills, resolutions" hyperlink; then follow "Bill summary and status" hyperlink; then search "Fracturing Responsibility and Awareness of Chemicals Act").

264. S. 587, 112th Cong. (2011); H.R. 1084, 112th Cong. (2011).

265. Department of the Interior, Environment, and Related Agencies Appropriations Act, H. Rep. 111-316, at 109 (2010); *Hydraulic Fracturing*, ENVTL PROT. AGENCY, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/index.cfm (last visited Apr. 5, 2011) [hereinafter *Hydraulic Fracturing Overview*].

266. *Id.*

267. *Id.*

assess risks and ultimately inform decision makers. The EPA has proposed four approaches to achieve this goal:[268]

1. "Compile and analyze background data and information."[269]
2. "Characterize chemical constituents relevant to hydraulic fracturing."[270]
3. "Conduct case studies and computational modeling."[271]
4. "Identify and evaluate technological solutions for risk mitigation and decision support."[272]

1. The Role of Case Studies

In conducting its study, the EPA intends to follow a case study approach, which is often used in in-depth investigations of complex issues like hydraulic fracturing. The EPA admits that, "developing a single, national perspective on [hydraulic fracturing] is complex due to geographical variations in water resources, geologic formations, and hydrology."[273] Nonetheless, the EPA's intention is that "the types of data and information that are collected through case studies should provide enough detail to determine the extent to which conclusions can be generalized at local, regional, and national scales."[274]

An initial set of research questions proposed by the EPA includes:

1. "What sampling strategies and analytical methods could be used to identify potential impacts on sources of drinking water, water supply wells, and receiving streams?"[275]

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268. *Opportunity for Stakeholder Input on EPA's Hydraulic Fracturing Research Study: Criteria for Selecting Case Studies*, ENVTL PROT. AGENCY, 1 (July 15, 2010), http://www.epa.gov/safewater/uic/pdfs/hydrofrac_casestudies.pdf [hereinafter *Opportunity for Stakeholder Input*].

269. *Id.*

270. *Id.*

271. *Id.*

272. *Id.*

273. *Id.* at 2.

274. *Id.*

275. *Id.*

2. "Are there vulnerable hydrogeologic settings where HF may impact the quality and availability of water supplies?"[276]
3. "How does the proximity of HF to abandoned and/or poorly constructed wells, faults, and fractures alter expected impacts on drinking water resources and human health?"[277]
4. "Is there evidence that pressurized methane or other gases, HF fluids, radionuclides, or other HF-associated contaminants can migrate into underground sources of drinking water? Under what conditions do these processes occur?"[278]

2. *Stakeholder Input and Study Timeline*

In June 2010, the EPA announced it would be holding four public information meetings in order to seek stakeholder and public input into developing its proposed study plan.[279] The EPA planned to complete the study design by September 2010, and initiate the study in January 2011.[280] It intends to have the initial study results available by late 2012.[281]

3. *Most Recent Developments in the EPA Study*

In the summer of 2010, the EPA added a statement to its website that "Any service company that performs hydraulic fracturing using diesel fuel must receive prior authorization from the UIC program. Injection wells receiving diesel fuel as a hydraulic fracturing additive will be considered Class II wells by the UIC program."[282] Industry groups filed a lawsuit against the

276. *Id.*

277. *Id.*

278. *Id.*

279. *Hydraulic Fracturing: Outreach*, ENVTL. PROT. AGENCY, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroout.cfm (last visited Apr. 5, 2011) [hereinafter *Outreach*].

280. *Hydraulic Fracturing Overview*, *supra* note 266; *see also* HYDRAULIC FRACTURING RESEARCH STUDY, *supra* note 11.

281. *Hydraulic Fracturing Overview*, *supra* note 266.

282. *Regulation of Hydraulic Fracturing by the Office of Water*, ENVTL. PROT. AGENCY, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/

EPA in the U.S. Court of Appeals for the D.C. Circuit contending that the website posting constituted a "final agency action" requiring certain procedural actions by the EPA prior to posting such as notice and public comment.[283] In response, the EPA maintains that its website statements are merely a description of existing legal obligations and a resolution of the lawsuit is still pending.[284]

In the meantime, the EPA research study is starting to take shape with the EPA recently announcing the experts chosen for the Science Advisory Board's (SAB) study review panel[285] The EPA submitted its draft study plan to the SAB for review and will revise the study plan in response to the SAB's comments before beginning the actual study, with initial research results expected by the end of 2012 with a goal for a report in 2014.[286]

E. Other Congressional Actions: Disclosure of Frac Fluid Chemicals

In addition to the FRAC Act and the EPA study, Congress has also separately requested information from the industry about the chemicals used in hydraulic fracturing.[287] On February 18, 2010, Henry A. Waxman, Chairman of the Subcommittee on Energy and Environment, and Subcommittee Chairman Edward Markey sent letters to eight oil and gas companies that use hydraulic fracturing "requesting information on the chemicals used in fracturing fluids and the potential

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wells_hydroreg.cfm#safehyfr (last visited Apr. 5, 2011).

283. Tom Zeller Jr., *Gas Drilling Technique Is Labeled Violation*, N.Y. TIMES, Feb. 1, 2011, at B1.

284. *Id.*

285. *Members of the Hydraulic Fracturing Study Plan Review Panel*, ENVTL. PROT. AGENCY SCI. ADVISORY BD., http://yosemite.epa.gov/sab/sabpeople.nsf/WebExternalSubCommitteeRosters?OpenView&committee=BOARD&subcommittee=Hydraulic%20Fracturing%20Study%20Plan%20Review%20Panel (last visited Apr. 5, 2011).

286. *Hydraulic Fracturing Overview*, *supra* note 266.

287. Press Release, Comm. on Energy and Commerce, Energy & Commerce Committee Investigates Potential Impacts of Hydraulic Fracturing (Feb. 18, 2010), *available at* http://energycommerce.house.gov/index.php?option=com_content&view=article&id=1896:energy-a-commerce-committee-investigates-potential-impacts-of-hydraulic-fracturing&catid=122:media-advisories&Itemid=55.

impact of the practice on the environment and human health."[288]

On July 19, 2010, Congressmen Waxman and Markey sent another letter requesting additional information from companies involved in hydraulic fracturing, including a list of the total volume of flowback and produced water recovered from wells, how the water was disposed of and a variety of other well specific data to determine the chemical content of flowback and produced water.[289] The companies did not thoroughly respond, and said "they were not able to provide data on the proximity of specific wells to underground sources of drinking water, or on the recovery and disposal of fluids and water that flowback to the surface of wells."[290]

F. *State Regulations and Actions Pending Potential Federal Action*

The EPA study and any legislative action taken by Congress may ultimately take several years to resolve.[291] In the meantime, and in response to the continued public scrutiny of shale gas drilling, some state governments have begun to amend or enact state laws and regulations in an effort to pre-empt the need for any eventual federal regulation of shale gas drilling operations.[292] For example, New York is currently in the process of completing a Supplemental Generic Environmental Impact Statement (SGEIS) for horizontal drilling and hydraulic fracturing[293] with a revised draft SGEIS expected in June

288. *Id.*

289. Letter from Rep. Henry A. Waxman, Chairman, Comm. on Energy and Commerce, to 10 Oil and Gas Companies (July 19, 2010), *available at* http://energycommerce.house.gov/documents/20100719/Letters.Hydraulic.Fracturing.07.19.2010.pdf; *see also* Press Release, Comm. on Energy and Commerce, Committee Requests More Details on Hydraulic Fracturing Practices (July 19, 2010), *available at* http://energycommerce.house.gov/index.php?option=com_content&view=article&id=2079:committee-requests-more-details-on-hydraulic-fracturing-practices&catid=154:correspondence&Itemid=55 [hereinafter Committee Requests More Details]

290. Committee Requests More Details, *supra* note 290.

291. *See supra* note 282 and accompanying text.

292. *See* Bailey, *supra* note 13, at 818.

293. *Marcellus Shale*, N.Y. Dept. of Envtl. Conservation, http://www.dec.ny.gov/

2011.[294] In the interim, and pursuant to an order issued by former New York Governor David Patterson, no permits for shale gas drilling may be issued.[295]

The suspension of drilling activity in New York may give that state time to learn lessons about hydraulic fracturing from its neighboring state, Pennsylvania, where more than 1000 wells have been drilled in the Marcellus Shale since 2005.[296] Those lessons may be difficult for the industry to learn. A recent report from the Pennsylvania Land Trust Association indicates that drillers in Pennsylvania have been cited for 1435 violations since 2008, 952 of which may affect the environment.[297] The article notes "[i]ssues listed in the report include improper construction of waste-water compounds used to store [fracing] fluids and violations of the state's clean stream law."[298]

On a more positive note, at least one company is taking action to address some of the environmental questions that have been raised.[299] On July 14, 2010, Range Resources announced a voluntary disclosure initiative for its Marcellus shale operations whereby Range will voluntarily submit to the Pennsylvania Department. of Environmental Protection additional information about additives used in the hydraulic fracturing process.[300] The company's press release notes that the "disclosure initiative will provide regulators, landowners and citizens of the Commonwealth an accounting of the highly diluted additives used at each well site, along with their classifications, volumes, dilution factors, and specific and common purposes."[301]

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energy/46288.html (last visited Apr. 5, 2011).

294. *Id.*

295. *Id.*

296. *Id.*

297. *Id.*

298. *Id.*

299. *See* Press Release, Range Resources, Range Resources Announces Voluntary Disclosure of Marcellus Shale Hydraulic Fracturing (July 14, 2010), *available at* http://www.rangeresources.com/rangeresources/files/4a/4ad3b135-4c37-4ebb-8923-dec985a70bea.pdf.

300. *Id.*

301. *Id.*

VII. CONCLUSION

The tremendous boom in shale gas production in the United States over the past five years has indeed been a game changer with potentially significant implications in terms of energy security and supply, climate change mitigation, and energy policy. While shale gas presents an enormous opportunity for the U.S. and perhaps the world, there are numerous legal, policy and environmental challenges that must be addressed before the full potential of shale gas can be realized. In the United States, this analysis is currently underway with the on-going EPA investigation and the recent re-introduction of the FRAC Act in the 112th Congress. While it is too soon to tell what the ultimate outcome will be, these developments should be closely watched as the world searches for the right energy policies for the 21st century.