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A COMPARISON BETWEEN SHALE GAS IN CHINA AND UNCONVENTIONAL FUEL DEVELOPMENT IN THE UNITED STATES: WATER, ENVIRONMENTAL PROTECTION, AND SUSTAINABLE DEVELOPMENT ***

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INTRODUCTION

China is believed to have the world's largest exploitable reserves of shale gas, however, several legal, regulatory, environmental, and investment-related hurdles will likely restrain its exploitation. China's capacity to face these hurdles successfully and produce commercial shale gas will have a crucial impact on the regional gas market and on China's energy mix, as Beijing strives to meet growing energy demand, and, at the same time, maintain a certain level of resource autonomy by decreasing its reliance on

imported oil and coal. The development of the unconventional natural gas extractive industry would also provide China with further negotiating power to obtain more advantageously priced gas.

This article, which adopts a comparative perspective, underlines the trends taken from unconventional fuel development in the United States, emphasizing their potential application to China in light of recently signed product-sharing agreements between qualified foreign investors and China. The wide range of regulatory and enforcement problems in this matter are increased by an extremely limited liberalization of gas prices, lack of technological development, and barriers to market access curbing access to resource extraction for private investors. This study analyzes the legal tools that can play a role in shale gas development while assessing the new legal and fiscal policies that should either be crafted or reinforced. It also examines the institutional settings' fragmentation and conflicts, highlighting how processes and outcomes are indeed path dependent. These issues are exacerbated by many concerns. One such concern is related to the risk of water pollution deriving from mismanaged drilling and fracturing. Another concern is the absence of adequate predictive evaluation regulatory instruments and industry standards, entailing consequences for social stability and environmental degradation, which are inconsistent with the purposes of sustainable development. Moreover, the possibilities of cooperation and coordination (including through U.S.-China common initiatives), and the role of transparency and disclosure of environmental data are assessed.

The significant growth in the production of natural gas from shale formations constitutes one of the most important developments in the energy sector. This growth was made possible by the reduction of production costs and overcoming of technological barriers. Recent advances in fracturing (also known as "fracking") and horizontal drilling technologies have led to a dramatic increase in shale gas production in the United States, which has resulted in energy experts describing shale gas as a "bridge fuel" to carbon-free renewable resources as the United States' primary

source of energy.[1] The U.S. Energy Information Administration (EIA)

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1. On the strategic relevance of shale gas in the United States, see Howard Rogers, *Shale gas—the Unfolding Story*, 27 OXFORD REV. ECON. POL'Y 117 (2011); Steffen Jenner & Alberto J. Lamadrid, *Shale Gas vs. Coal: Policy Implications from Environmental Impact Comparisons of Shale Gas, Conventional Gas, and Coal on Air, Water, and Land in the United States*, 53 ENERGY POL'Y 442 (2013). An interesting comparative analysis between shale

estimates a 49 percent growth in global marketed energy consumption by 2035.[2] Unconventional fossil fuel energy resources will grow approximately 4.9 percent per year up to 2035.[3] Furthermore, shale formations are found in almost every region of the globe; thus the potential for shale gas development is of great importance.[4]

Although shale gas represents a revolutionary element in the global energy framework, several regulatory and environmental concerns related to both its extraction and production processes have been raised, in particular about the use of hydraulic fracturing fluids and the consequential risk of drinking water contamination.[5] As the "shale gas revolution" taking place in the United States has highlighted, human health and environmental concerns continue to dog shale gas development.[6] In

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gas development in China and the United States was carried out by Joshua Harvey and Yang Min in the framework of the Vermont Law School-China Partnership for Environmental Law. In particular, see Joshua Harvey & Yang Min, *The Unconventional Promise and Problems of Shale Gas Development in the US and China: A Comparative Study*, VLA-CHINA PARTNERSHIP ENVT'L L., May 13, 2011, at 1.

2. That is, compared to a 2007 prerecession baseline. The EIA predicts that unconventional fossil fuel energy resources will grow at approximately 4.9 percent per year until 2035. U.S. Energy Info. Admin., *International Energy Outlook 2010*, DOE/EIA-0484(2010), at 1–9 (July 2010), http://large.stanford.edu/courses/2010/ph240/riley2/docs/EIA-0484-2010.pdf.

3. *See, e.g.*, Stephen A. Holditch, *The Increasing Role of Unconventional Reservoirs in the Future of Oil and Gas Business*, 55 J. PETROLEUM TECH. 34, 34 (Nov. 2003) (defining conventional reservoirs of oil and gas as "those that can be produced at economic flow rates and that will produce economic volumes of oil and gas without large stimulation treatments or any special recovery process," whereas Holditch defines unconventional reservoirs of oil and gas as those "that cannot be produced at economic flowrates or that does not produce economic volumes of oil and gas without assistance from massive stimulation treatments or special recovery processes and technologies").

4. Christophe McGlade et al., *Unconventional Gas–A Review of Regional and Global Resource Estimates* 55 ENERGY 571, at 12–14 (2013).

5. Hydraulic fracturing implies the high-pressure injection of millions of gallons of water-based hydraulic fracturing fluids to increase the permeability of the rock by holding the fractures open. Fracturing fluid is a mixture of about 90 percent water, 9.5 percent sand, and 0.5 percent chemical additives. *See generally* EPA, *Hydraulic Fracturing Research Study*, 2010. For a comprehensive overview of the legal rules governing the management of drinking water, see generally Richard J. Lazarus, *Crystals and Mud in Nature*, 18 YALE J.L. & HUMAN. 134 (2006).

6. Stephen G. Osborn et al., *Methane Contamination of Drinking Water Accompanying Gas-well Drilling and Hydraulic Fracturing*, 108 PROC. NAT'L

that respect, given the global scope of its potential, it is crucial to ensure that the development of shale gas resources will be carried out in an environmentally sound manner.[7]

China is aware of the importance of unconventional gas as a carbon-friendly energy source and pivotal element in achieving the country's future energy and environmental objectives. As it is the country with the largest increase in greenhouse gas ("GHG") emissions, China's capacity to substitute coal with cheaper gas as its primary electricity-generating fuel has the potential to represent a huge step toward global warming mitigation.[8] However, China lacks comprehensive legal instruments capable of addressing the potential environmental hazards of shale gas extraction, and suffers from weak enforcement of environmental laws and regulations.[9]

This article begins with Part I examining the implications of shale gas on the world's energy market and its relevance regarding energy security, the recent vast increase in shale gas production, and its potential for China's energy mix and supply. In Part II, the article investigates the current Chinese regulatory framework, which lacks cohesive and satisfactory provisions regarding shale gas extraction. Specifically, Part II will examine the institutional shortcomings that hinder effective

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ACAD. SCI. 8172 (2011); David M. Kargbo et al., *Natural Gas Plays in the Marcellus Shale: Challenges and Potential Opportunities,* 44 ENVTL./ SCI. & TECH. 5679 (2010); Charles W. Schmidt, *Blind Rush? Shale Gas Boom Proceeds Amid Human Health Questions* 119 ENVTL. HEALTH PERSP. A348 (2011); Robert W. Howarth et al., *Natural Gas: Should Fracking Stop?*, 477 NATURE 271 (2011).

7. *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); Eleanor Stephenson et al., *Greenwashing Gas: Might a 'Transition Fuel' Label Legitimize Carbon-intensive Natural Gas Development?*, 46 ENERGY POL'Y 452 (2012).

8. *See generally* Choi Ieng Chu et al., *The Current Status of Greenhouse Gas Reporting by Chinese Companies: A Test of Legitimacy Theory,* 28 MANAGERIAL AUDITING J. 114 (2013); Mingde Cao, *Greenhouse Gas Emission Reduction,* 43 ENVTL. POL'Y & L. 52 (2013); Zhu Liu et al., *Uncovering China's Greenhouse Gas Emission from Regional and Sectorial Perspectives,* 45 ENERGY 1059 (2012); Lorraine Sugar et al., *Greenhouse Gas Emissions from Chinese Cities,* 16 J. INDUS. ECOLOGY 552 (2012); Hong Huo et al., *Projection of Energy Use and Greenhouse Gas Emissions by Motor vehicles in China: Policy Options and Impacts,* 43 ENERGY POL'Y 37 (2012).

9. *See infra*, Part II, for a discussion about the Chinese institutional and regulatory framework.

enforcement of environmental provisions, the pricing and fiscal regime, and the current barriers to foreign investment access to the Chinese energy market, which strongly counters China's need for technology and know-how. This analysis points out that there are no Chinese laws that explicitly tackle the environmental risks of the fracking process. Part III discusses critical concerns about fresh water management vis-à-vis unconventional gas.[10] These two natural resources have come to be complexly linked because the extraction, treatment, and distribution of fresh water entail considerable energy, while the production of fossil fuel energy involves fresh water.

Part IV discusses the similarities between China and the United States regarding shale gas. Shale gas is a pivotal element for the energy future of both countries, where energy security, energy efficiency, and environmental concerns are deeply intertwined. Their regulatory frameworks are not completely dissimilar, as both have far-reaching federal or central laws enforced by designated agencies. Furthermore, both countries exhibit a gap between the formulation of federal/central law and their enforcement at the local level. The similarities between the U.S. and Chinese energy systems allow for the drawing of parallels, which could be beneficial to the Chinese shale gas industry. In that perspective, this article argues that the current applicable Chinese legal framework is neither sufficient nor satisfactory, given what is at stake. In particular, it questions how shale gas can represent a transitional fuel to renewable energy resources.

Part V discusses how shale gas radically impacts supply and demand of the world's energy mix and market, how new geopolitical factors must be assessed, how economic and demographic growth will increase pressure on global energy supplies, and, as a result, how all fuel sources will have to be exploited. This article concludes that a comprehensive legal and regulatory change is necessary in order to foster an environmentally sound development of the shale gas sector in China. This change would be conducive to the need to increase energy security, to achieve the country's future energy and environmental

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10. For a wider debate on the carbon footprint of unconventional gas, see Robert H. Abrams & Noah D. Hall, *Framing Water Policy in a Carbon Affected and Carbon Constrained Environment*, 50 NAT. RESOURCES J. 3, 7 (2010).

objectives, and to ensure beneficial economic growth and social development.

I. The Revolutionary Role of Shale Gas through the Prism of China's Energy Mix: the Growth of a New Industry

The potential for shale gas development is currently being explored in several countries.[11] Shale gas is found in unconventional reservoirs, from which natural gas is extracted from the low permeable source rock itself using a combination of techniques such as hydraulic fracturing[12] and horizontal drilling,[13] which create fissures in the rock allowing the gas to flow more easily through it. In addition to shale gas resources, there are other types of unconventional gas reservoirs: tight gas[14] and coal bed methane ("CBM").[15] That said, the present article focuses on shale gas due to recent enormous increase in shale gas

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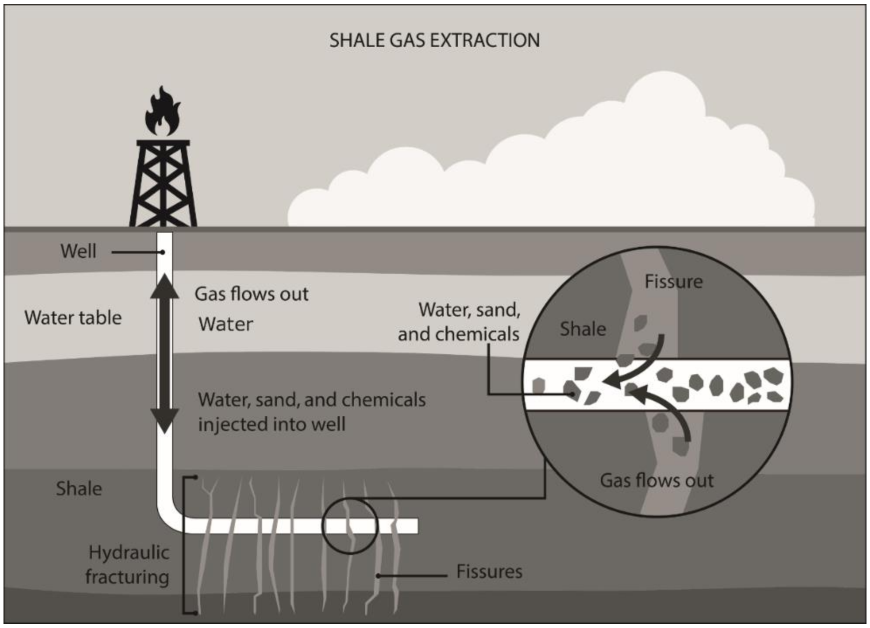
11. Shale gas development is currently being explored in several countries, and shale gas reserves have been identified in some European countries and in Algeria, Libya, Morocco, Tunisia, South Africa, Argentina, Brazil, Bolivia, Chile, Colombia, Mexico, Paraguay, Uruguay, Venezuela, India, Pakistan, and China. 137 exploratory drilling operations are currently underway in China and in parts of South America, particularly Argentina.

12. For a definition of "hydraulic fracturing," see *Hydraulic Fracturing Research Study*, *supra* note 5.

13. Horizontal drilling involves drilling a vertical well to the desired depth and then drilling laterally to access a larger portion of the reservoir. George E. King, Apache Corporation, *Hydraulic Fracturing 101: What Every Representative, Environmentalist, Regulator, Reporter, Investor, University Researcher, Neighbor and Engineer Should Know about Estimating Frac Risk and Improving Frac Performance in Unconventional Gas and Oil Wells* (SPE Hydraulic Fracturing Technology Conference, February 6-8, 2012).

14. Tight gas refers to natural gas that is trapped in sandstones. For the significance of this energy source in China, see Dai Jinxini et al., *Tight Gas in China and Its Significance in Exploration and Exploitation*, 39 PETROLEUM EXPLORATION & DEV. 277 (2012).

15. CBM is a natural gas that is produced from coal seams, which act as the source and reservoir for natural gas. Historically, China's focus has been on CBM, but recently its focus has shifted towards developing its shale gas resources. Yumin Lv, Dazhen Tang, Hao Xu & Haohan Luo, *Production Characteristics and the Key Factors in High-Rank Coalbed Methane Fields: A Case Study on the Fanzhuang Block, Southern Qinshui Basin, China*, 96 INT'L J. COAL GEOLOGY 93 (2012). The term "unconventional gas" is used herein to indicate shale gas, which has been acknowledged as the most promising unconventional gas.



production and its potential for China's energy mix and supply.[16]

Figure 1. Illustrative diagram of fracking and horizontal drilling operations.

A. A Transition Toward a More Sustainable Future?

Shale gas is widely referred to as a "bridge fuel," implying its capability to eventually replace hydrocarbons with carbon-free renewable resources as a primary source of energy.[17] This con-

16. China's potential unconventional gas reservoirs are significant, although many still need to be more precisely estimated. The political support of shale gas is also relevant, and the Chinese Ministry of Land and Resources ("MLR") announced "a strategic goal of reaching a production target of 15–30 BCM (billion cubic meters) by 2020." *See* INT'L ENERGY AGENCY, MEDIUM-TERM OIL & GAS MARKETS 185 (2010). To achieve this goal, China must, inter alia, acquire fracking technology and expertise. The state-owned company Sinopec has already launched dialogue with international oil companies in furtherance of this goal. What is more, in November 2009, China and the United States signed a Memorandum of Understanding ("MoU") to jointly cooperate in assessing China's shale gas resources and foster investments in this sector. *See id.* at 185, 188.

17. *See* Noam Lior, *Sustainable Energy Development with Some Game-Changers*, 40 ENERGY 3, 4 (2012). *See generally* Hanna Mäkinen, *Shale Gas–a Game Changer in the Global Energy Play?*, 1 BALTIC RIM ECON. 31 (2010);

cept acknowledges that renewable resources cannot replace hydrocarbons as a primary generating fuel in the near term, and that, while shale gas remains a hydrocarbon, it has less detrimental consequences on the environment than other fossil fuels.[18] In that respect, it appears that at the moment, renewable resources are less cost competitive than fossil fuels, in particular natural gas.[19]

Moreover, in addition to their high costs, renewable resources present further downsides, including the need for installing thousands of miles of new transmission lines requiring onerous investments and burdensome regulatory approvals. With the European Union and the United States examining ways to develop electricity projects that use renewable resources to generate electricity and to market the electricity produced by such projects, it appears that they mainly rely on the continued availability of federal and state subsidies and state-renewable resource portfolio mandates.[20] Given the ongoing global finan-

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Amy Myers Jaffe, *Shale Gas Will Rock the World*, WALL ST. J. (May 10, 2010), http://www.wsj.com/articles/SB10001424052702303491304575187880596301668; PAUL STEVENS, THE 'SHALE GAS REVOLUTION': HYPE AND REALITY (2010); Martin Wolf, *Prepare for a Golden Age of Gas*, REAL CLEAR MARKETS, Feb. 22, 2012, http://www1.realclearmarkets.com/2012/02/22/prepare_for_a_golden_age_of_natural_gas_123804.html.

18. *See generally* STEVENS, *supra* note 17.

19. It costs two to five times as much to generate electricity through the use of renewable resources such as solar and wind as through use of gas. Furthermore, given that most renewables can generate electricity exclusively on an intermittent basis, a unit of electricity generated through the use of a renewable resource is worth only about 25 percent as much as a unit of electricity generated through the use of gas. Paul L. Joskow, *Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies*, 100 AM. ECON. REV.: PAPERS & PROCEEDINGS 238 (2011); Paolo D. Farah & Elena Cima, *Energy Trade and the WTO: Implications for Renewable Energy and the OPEC Cartel*, 16 J. INT'L ECON. L. 707 (2013).

20. Manuel Frondel et al., *Economic Impacts from the Promotion of Renewable Energy Technologies: The German Experience* (Ruhr Economic Papers, No. 156 (2009); Richard Schmalensee, *Evaluating Policies to Increase Electricity Generation from Renewable Energy,* 6 REV. ENVTL. ECON. & POL'Y 45 (2012); Mark A. Delucchi & Mark Z. Jacobson, *Providing All Global Energy with Wind, Water and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infastructure and Materials*, 39 ENERGY POL'Y 1170 (2011); Keith Williges et al., *Making Concentrated Solar Power Competitive With Coal: The Costs of a European Feed-in Tariff,* 38 ENERGY POL'Y 3089 (2010); Paul Lehmann & Erik Gawel, *Why*

cial recession, however, those subsidies and mandates are unlikely to be granted in the future. Rather, many EU countries have already either reduced or eliminated those subsidies.[21]

On the other hand, the replacement of coal with natural gas, including shale gas, as a generating fuel reduces emissions of carbon dioxide. Hence, the expression "bridge fuel" reflects the expectation of many policy makers that we can achieve mitigation of climate change in the near term by replacing coal with natural gas, while eventually entirely replacing all hydrocarbons with carbon-free renewable resources in the long term.[22] Clearly the practicality of this scenario is dependent on the ability to take adequate measures to guarantee society that hydraulic fracturing of shale basins can be carried out with low environmental costs.

China is likely to benefit greatly from shale gas. The International Energy Agency (IEA) predicts that China will consume more gas than the entire EU by 2035.[23] As it is the country

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Should Support Schemes for Renewable Electricity Complement the EU Emissions Trading Scheme?, 52 ENERGY POL'Y 597 (2013).

21. For instance, Portugal and Spain made the extraordinary decision of reneging on the long-term commitments they made to renewable resource projects by retroactively eliminating their subsidies. This way, the two Iberian countries saved many billions of Euros in the efforts to avoid defaulting on their sovereign debt.

22. Richard J. Pierce, Jr., *Natural Gas: A Long Bridge to a Promising Destination*, 32 UTAH ENVTL. L. REV. 245 (2012). *See also* Daniel P. Schrag, *Is Shale Gas Good for Climate Change?*, DÆDALUS, J. AM. ACAD. ARTS & SCI., Spring 2012, at 72. On the other hand, unconventional natural gas production is noted for its potential for significantly large quantities of methane leakage, which is a potent GHG. During oil and gas production processes, fugitive methane emissions are most commonly leaked or intentionally vented at the wellhead, and from pipes and valves. Merisha Enoe et al., *Lessons Learned: A Path Toward Responsible Development of China's Shale Gas Resources*, NAT. RESOURCES DEF. COUNCIL, Aug. 2012, at 1, 6, http://www.nrdc.cn/phpcms/userfiles/download/201208/16/Lessons%20Learned%20-%20A%20Path%20Toward%20Responsible%20Development%20of%20China%E2%80%99s%20Shale%20Gas%20Resources.pdf. For an argument that dynamic governance innovation can facilitate climate-energy-water balancing to address natural gas governance gaps, see Elizabeth Burleson, *Climate Change and Natural Gas Dynamic Governance*, 63 CASE W. RES. L. REV. 1, 25 (2013).

23. INT'L ENERGY AGENCY, ARE WE ENTERING A GOLDEN AGE OF GAS?: WORLD ENERGY OUTLOOK, at 8 (2011),

with the largest source of GHG emissions and the largest source of increase in GHG emissions, China's capacity to substitute coal with cheaper gas as its primary electricity-generating fuel has the potential to represent a huge step toward global warming mitigation.[24]

However, relying on shale gas introduces the risk of neglecting investments in renewable energies. Some critics say that the industry's focus on developing shale gas and other unconventional sources is diverting attention and capital from the development of renewables because low-cost power is generated from copious natural gas supplies, which could frustrate the economic viability of wind, solar, and geothermal projects, and eventually delay the shift to renewable energies by many years.[25] Indeed, in the United States, shale gas as a source of low-priced electric power created a more difficult competitive environment for new wind projects.[26] Similarly, the IEA suggests that the effect of falling gas prices due to increased shale gas development could hamper the viability of low-carbon alternatives.[27] Nevertheless, it is important to bear in mind that it is not certain that gas prices will remain low if shale gas must meet tighter regulatory criteria. Additionally, the ultimate price competitor in the power sector is not gas, but coal

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http://www.worldenergyoutlook.org/media/weowebsite/2011/weo2011_goldenageofgasreport.pdf.

24. For a scientific perspective on the fact that a significant part of recent global warming is driven by the accumulation of anthropogenically derived greenhouse active gases in the Earth's atmosphere, see John Dodsonn, *Introduction*, *in* CHANGING CLIMATES, EARTH SYSTEMS AND SOCIETY, at xix (John Dodson ed., 2010).

25. In light of the great potential for investments in carbon markets, renewable energy sources, and low-carbon technologies, it is clear that international investment, renewables, and climate change are interdependent concepts. On this point, see generally Kate Miles, Soc'y of Int'l Econ. Law Inaugural Conference, *Issues in the Transition to a Low Carbon World* (July 2, 2008), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1154588.

26. *See generally* DANIEL YERGIN, THE QUEST: ENERGY SECURITY AND THE REMAKING OF THE MODERN WORLD (2011).

27. This was confirmed by the chief economist of the IEA, Fatih Birol, who stated, "if gas prices come down, that would put a lot of pressure on governments to review their existing renewable energy support policies . . . . We may see many renewable energy projects put on the shelf." Fiona Harvey, *Natural Gas is No Climate Change 'Panacea', Warns IEA,* GUARDIAN (June 6, 2011), http://www.theguardian.com/environment/2011/jun/06/natural-gas-climate-change-no-panacea.

(and, for base load capacity, nuclear, and hydropower). On this point, Jenner and Lamadrid remark:

> the crucial challenge in order to achieve grid parity is to meet the coal price. This objective can be approached from two sides: increased cost effectiveness of renewable energies and storage solutions by further technological innovation; or internalization of the cost of carbon into the price of coal. Both ways are relatively independent from the shale gas issue.[28]

In other words, "shale gas holds the potential to smoothen the transition to an age of renewable energies but we must be aware of the potential of low gas prices to cause temporarily a spike."[29]

Extreme reliance on natural gas would equally frustrate the efforts to maintain fuel mix diversity in the power sector, leaving ratepayers, utilities, and the economy as a whole vulnerable to the hazards of commodity price volatility. In that sense, substitution of natural gas for other fossil fuels cannot be the exclusive means to tackle GHG emissions and climate change, given that natural gas is itself a fossil fuel. Further complementary actions are then needed in order to have a reasonable chance of meeting climate goals.[30] To this end, low-carbon investments, renewable energy deployment, carbon capture and storage technologies, and energy efficient measures must be prioritized in the international energy governance agenda. Another critical step in the right direction would be the establishment of a carbon tax that would allow negative externalities related to fossil fuels not to be priced by society.[31] Finally,

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28. S. Jenner & A.J. Lamadrid, *supra* note 1, at 449. On the internalization of the cost of carbon into the price of coal, see generally, David M. Driesen, *Putting a Price on Carbon: The Metaphor*, 44 ENVTL. L. 695 (2014); David M. Driesen, *The Limits of Pricing Carbon*, 4 CLIMATE L. 107 (2014).

29. *Id.*

30. Instead of being thought of as competitors, however, natural gas and renewable energy sources should be seen as complementary, not competitive, components of the power sector. Natural gas plants can quickly scale up or down their electricity production, and thus can act as an effective hedge against the intermittency of renewables. CTR. FOR CLIMATE & ENERGY SOLUTIONS, LEVERAGING NATURAL GAS TO REDUCE GREENHOUSE GAS EMISSIONS, at vii (2013), http://www.c2es.org/docUploads/leveraging-natural-gas-reduce-ghg-emissions.pdf.

31. William D. Nordhaus, *To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming*, 1 REV. ENVTL. ECON. POL'Y 26, 26 (2007); Liang

further actions would require the development of a real-time pricing mechanism for electricity[32] and the reduction of direct releases of methane into the atmosphere during the extraction process. Emissions of methane are mainly caused by "flowback" of the water forced into the rock formation during fracking, and by leaks in processing and during transportation.[33] Recent studies suggest that these losses can be limited by the use of the best technology, but cannot be completely avoided.[34] In that respect, it is crucial to measure precisely GHG emissions from both natural gas production and consumption in order to minimize emissions along the entire natural gas chain.[35] As technologies for producing shale gas continue to advance and the industry grows in scale, wider collaboration on research and development issues is required among governmental agencies and international energy governance institutions.

In light of the aforesaid, a growing body of scientific research questions how shale gas could ever be a transitional fuel that is able to shift society from its current overreliance on fossil fuels to a greater use of sustainable renewable energy, given its carbon intensity and the level of investment needed.[36] Further-

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Qiao-Mei et al., *Carbon Taxation Policy in China: How to Protect Energy-and Trade-Intensive Sectors?*, 29 J. POL'Y MODELING 311, 312 (2007).

32. Mark G. Lijesen, *The Real-Time Price Elasticity of Electricity*, 29 ENERGY ECON. 249 (2007); Stephen P. Holland & Erin T. Mansur, *Is Real-Time Pricing Green? The Environmental Impacts of Electricity Demand Variance*, 90 REV. ECON. & STAT. 550, 550 (2008); Hunt Allcott, *Rethinking Real-time Electricity Pricing*, 33 RESOURCE & ENERGY ECON. 820, 820 (2011).

33. CTR. FOR CLIMATE & ENERGY SOLUTIONS, LEVERAGING NATURAL GAS TO REDUCE GREENHOUSE GAS EMISSIONS 22 (2013), http://www.c2es.org/docUploads/leveraging-natural-gas-reduce-ghg-emissions.pdf.

34. Recent scientific research indicates that relying on shale gas could in fact be as harmful to the climate as reliance on coal. Robert W. Howarth et al., *Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations*, 106 CLIMATIC CHANGE 679, 686–87 (2011).

35. Indeed, natural gas is not carbon free. On the contrary, it releases emissions by its combustion. Moreover it contains methane (CH4), a potent GHG, whose release during production, transmission, and distribution may offset the beneficial climate outcome of shale gas use.

36. On this point, Nobuo Tanaka, executive director of the IEA, stated, "While natural gas is the cleanest fossil fuel, it is still a fossil fuel. Its increased use could muscle out low carbon fuels such as renewables . . . an expansion of gas use alone is no panacea for climate change." *See* Harvey, *supra* note 27. Indeed, according to studies carried out by the IEA, the development of the shale gas industry would put our CO_2 emissions on a "trajectory con-

more, shale gas would most likely involve costly regulation. Provided that natural and shale gas prices remain low, there will be fewer inducements to invest in greener sources. Hence, in order to satisfy their carbon-reduction targets, there is a risk that governments could force the energy industry to make these investments through regulation, which would greatly augment costs across the entire oil and gas industry, and result in repercussions on highly cost-sensitive shale gas investments, projects, and operations.

B. China's Stake in the Shale Gas Saga

Shale gas is already revolutionizing the world's energy markets and industry. Vast deposits are being discovered throughout the world. China is aware of unconventional gas's role as a carbon-friendly energy source and pivotal element in achieving the country's future energy and environmental objectives: increasing energy security, decreasing GHG emissions,[37] and ameliorating domestic air quality while simultaneously empowering the country to pursue beneficial economic growth and social development.[38] A 2013 assessment of international shale gas resources issued by the U.S. EIA[39] estimated technically

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sistent with a probable temperature rise of more than 3.5 degrees Celsius in the long term." INT'L ENERGY AGENCY (IEA), GOLDEN RULES FOR A GOLDEN AGE OF GAS 91 (2012), http://www.worldenergyoutlook.org/weo2009/. *See generally* David M. Driesen, *Phasing Out Fossil Fuels*, 38 NOVA L. REV. 523 (2013); Jody Freeman, *A Critical Look at* "The Moral Case for Fossil Fuels", 36 ENERGY L.J. 327 (2015).

37. According to the Kyoto Protocol's emission-reduction obligations, the Chinese government announced on November 25, 2009, that China's unit GDP CO_2 emissions will decrease by 40 to 45 percent from 2005 to 2020. Margret Kim & Robert Jones, *China's Energy Security and the Climate Change Conundrum*, NAT. RESOURCES & ENV'T, 2005, at 3, 6; Deng Haifeng, *Legal Interactive Mechanism on Climate Change: A Comparative Study of China and U.S. Experiences,* 8 US-CHINA L. REV. 431, 431–44 (2011); Paul Howard, *Harmony in China's Climate Change Policy, in* CLIMATE CHANGE AND GROWTH IN ASIA 177 (M. Hossain & E. Selvanathan eds., 2011).

38. For a prediction of Chinese energy consumption and carbon dioxide emissions in a scenario of the all-inclusive well-off society in 2020, see Wei Lu & Yitai Ma, *Image of Energy Consumption of Well Off Society in China*, 45 ENERGY CONVERSION & MGMT. 1357 (2004). On the relationship between economic growth and social development, see, for example, Gheorhe H. Popescu, *The Social Evolution of China's Economic Growth,* 1 CONTEMP. READINGS L. & SOC. JUST. 88, 90 (2013).

39. The EIA is an independent arm of the U.S. DOE.

recoverable shale gas resources in China at 1115 trillion cubic feet,[40] nearly 50 percent more than resources in the United States.[41] In reality, China's national oil companies have already commenced shale gas exploratory drilling with the technical and financial assistance of joint ventures with multinational companies such as Total, BP, and Royal Dutch Shell.[42] The rigid structure of China's state-controlled oil and gas industry hampers efforts to exploit reserves, because the current absence of competition between the three state-owned energy giants (China National Petroleum Corporation (CNPC), Sinopec, and PetroChina) is not conducive to a fair allocation of resources. In that sense, the country's current energy regulation is characterized by overregulation of the energy market, a fragmented system of regulation, and insufficient environmental regulation.[43] Moreover, numerous Chinese investments in North American shale basins illustrates Beijing's concrete commitment to exploring the potential of shale gas resources, as China is exponentially building its shale gas capacity in order to achieve energy security and influence in the world's gas-pricing regimes.[44] What emerges is a growing Chi-

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40. U.S. ENERGY INFO. ADMIN., TECHNICALLY RECOVERABLE SHALE OIL AND SHALE GAS RESOURCES: AN ASSESSMENT OF 137 SHALE FORMATIONS IN 41 COUNTRIES OUTSIDE THE UNITED STATES 6 (2013). *See also* Li Shizhen, *The Status of World Shale Gas Exploration and Development and Implications for China,* 6 GEOLOGICAL BULL. 918 (2010).

41. China has an estimated 1115 Tcf of risked, technically recoverable shale gas, located mainly in marine- and lacustrine-deposited source rock shales of the Sichuan (626 Tcf), Tarim (216 Tcf), Junggar (36 Tcf), and Songliao (16 Tcf) basins. Additionally, technically recoverable shale gas resources totaling 222 Tcf exist in the smaller, structurally more complex, Yangtze Platform, Jianghan, and Subei basins. Shale gas leasing and exploration drilling are already underway in China, primarily in the Sichuan Basin and Yangtze Platform areas and are led by PetroChina, Sinopec, and Shell. The government has set an ambitious but probably unachievable target for shale gas production of 5.8 to 9.7 Bcfd by 2020. *See* McGlade et al., *supra* note 4.

42. *Id.*

43. Xin Qiu & Honglin Li, *Energy Regulation and Legislation in China* 42 ENVTL. L. REP. 10678 (2012).

44. Globally, States engage in multilateral or bilateral inter-State relations to pursue energy security, while building up extensive reserves that inevitably impact on the world's oil and gas supply. Paolo Davide Farah & Piercarlo Rossi, *National Energy Policies and Energy Security in the Context of Climate Change and Global Environmental Risks: A Theoretical Framework for Reconciling Domestic and International Law through a Multiscalar*

nese engagement in international relations in order to guarantee a steady energy supply for its ever-increasing domestic needs.[45] At the moment, natural gas demand continues to exceed supply, making China a net importer; but, at the same time, domestic production has been burgeoning,[46] increasing the share of natural gas in total energy requirements from 2 percent to 4 percent, and expected to reach 8 percent by 2015 and 10 percent by 2020.[47]

However, after assessing the development of the shale gas industry in China, one can see that the current applicable legal framework is neither sufficient nor satisfactory given what is at stake. China must still adequately delineate a policy framework regarding pricing mechanisms, energy regulation, and physical infrastructures, as well as management of environmental risks that may be connected to the development of its unconventional gas resources. The exploitation of natural reserves is a strategic sector for national security and, in that sense, is highly sensitive to political influences and extremely prone to State intervention. The central government firmly controls shale gas blocks by granting exploration rights and

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and Multilevel Approach, 20 EUR. ENERGY & ENVTL. L. REV. 232, 232–34 (2011); Rafael Leal-Arcas & Andrew Filis, *The Fragmented Governance of the Global Energy Economy: a Legal-Institutional Analysis* 6 J. WORLD ENERGY L. & BUS. 1, 4 (2013).

45. Andreas Goldthau, *Energy Diplomacy in Trade and Investment in Oil and Gas, in* GLOBAL ENERGY GOVERNANCE: THE NEW RULES OF THE GAME 25, 25 (2010).

46. China augmented natural gas domestic production from 27.2 billion cubic meters (bcm) in 2001 (approximately 106 percent of domestic consumption) to 94.5 bcm in 2010 (approximately 89 percent of domestic consumption). Given the continuously increasing domestic need, China is also implementing its energy infrastructure network. In that respect, the 4200-km West-to-East pipeline was built to transport gas from Xinjiang Province in the west to Shanghai, and the TransAsian pipeline was opened in 2009 to bring gas from Turkmenistan to China. Moreover, four liquefied natural gas ("LNG") receiving terminals were brought online, allowing LNG to meet some 10 percent of Chinese gas demand. A few more LNG receiving terminals are under construction. *See* McGlade et al., *supra* note 4; Ruud Weijermars & Crispian McCredie, *Assessing Shale Gas Potential*, PETROLEUM REV., Oct. 2011, at 1.

47. Boqiang Lin & Ting Wang, *Forecasting Natural Gas Supply in China: Production Peak and Import Trends,* 49 ENERGY POL'Y 225, (2012); Guy CK Leung, *China's Energy Security: Perception and Reality*, 39 ENERGY POL'Y 1330 (2011); OIL AND GAS RESOURCES IN CHINA: A ROADMAP TO 2050 (Guangding Liu et al. eds., 2011); Junchen Li et al., *Forecasting the Growth of China's Natural Gas Consumption*, 36 ENERGY 1380 (2011).

organizing auctions. The first round of tendering for shale gas exploration rights in June 2011 was held in the form of an invitation tender, and only State- and province-controlled oil and gas enterprises were able to bid on the gas drilling projects, namely, China National Off-shore Oil Corporation (CNOOC), Sinopec, PetroChina, Yanchang Petroleum, China United Coalbed Methane Corporation, and Henan CBM.[48] The exclusion of foreign companies from being eligible to obtain production licenses was possibly aimed at retaining control over the scope of investments and the production ratio. The second round of tendering was held in October 2012, which opened bidding to state-owned enterprises in other industries as well as privately-held Chinese investment entities (Sinochem and Zhenhua Oil) in order to foster greater competition and innovativeness in the infant shale gas industry.[49] However, the Chinese government still has enormous leeway in deciding which enterprises can access its shale gas industry, and the entry of non-state Chinese companies will not change this situation given that these entities continue to rely on cooperation with State-controlled PetroChina, which owns and runs the national transmission network.[50] Nevertheless, foreign companies are neither able to bid nor act independently for either extraction or infrastructure projects, as they are merely allowed to operate under approved joint ventures with Chinese firms. Domestic companies apply for permits to explore and develop sites, after which they can enter into partnerships with foreign investors.[51]

State-owned enterprises such as CNPC and CNOOC can acquire specific technical skills by investing in North American shale gas companies and establishing joint ventures. For in-

48. U.S. Energy Info. Admin., *China – International Energy Data and Analysis* (May 14, 2015), https://www.eia.gov/beta/international/analysis_includes/countries_long/China/china.pdf.

49. Cameron McKenna, *Shale Gas: Legal Developments in Some Key Jurisdictions Across the Globe*, LEXOLOGY (Dec. 5, 2011), http://www.lexology.com/library/detail.aspx?g=0e5143b6-f9d2-45b0-bbeb-bd8805b6a572.

50. Christina Larson, *China's Shale-Gas Potential and Peril*, BLOOMBERG BUS. WEEK, (Apr. 18, 2013), http://www.bloomberg.com/bw/articles/2013-04-18/chinas-shale-gas-potential-and-peril.

51. KPMG GLOB. ENERGY INST., SHALE GAS: GLOBAL M&A TRENDS 11 (2012).

stance, Shell and CNPC have partnered in digging more than thirty gas wells in Middle Sichuan Province, and discovered shale gas in Fushun-Yongchuan Block, which is considered the first commercial shale gas project in China.[52] The two companies signed the first production-sharing agreement approved for foreign involvement in the shale gas sector.[53] Usually foreign oil and gas companies seek to join product sharing agreements ("PSAs"), which represent the classic form of contracting of oil and gas resources. Similarly, Statoil, ConocoPhillips, BP, Chevron, and Exxon Mobil have entered into joint study agreements with Chinese national oil companies and they are likely to transform their agreements into PSAs later on.[54]

In a PSA, an international oil company is more of a partner in the venture, and shares both the resulting oil and control of the operation either directly or through a joint-operation body. PSAs can be beneficial to governments of countries that lack the expertise and capital to exploit their natural resources and wish to attract foreign companies to do so. An international oil company usually shares the resulting profits and oil/gas, but is obligated to pay not only royalties but also income tax on its share. An alternative method to approaching the market is to acquire or enter into a cooperation agreement with a local oil or gas field service provider.

The principal technique to foster production and use of unconventional natural gas is through government-set goals and mandates, which State-run entities, with some participation from private companies, pursue with projects and adequate investments. The vast participation in the aforementioned tenders reflects the market enthusiasm concerning the potential of the shale gas industry. However, lack of experience will carry relevant hindrances on shale gas exploitation in China. Lack of

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52. *Unconventional Oil & Gas Resources*, CHINESE NAT'L PETROL. CORP., http://www.cnpc.com.cn/en/umconventional/common_index.shtml (last visited Mar. 6, 2016).

53. Shell committed to contributing at least $1 billion each year for the joint venture to fund exploration. *Shell Plans to Spend $1 Billion a Year on China Gas*, BLOOMBERG NEWS, (Mar. 28, 2013), http://www.bloomberg.com/news/articles/2013-03-26/shell-plans-to-spend-1-billion-on-china-shale-gas-development.

54. Edwin Lee, *Shale Gas in China: How Far From Dream to Reality?*, LEXOLOGY (June 3, 2013), http://www.lexology.com/library/detail.aspx?g=4744bcac-ffd4-4db5-ac27-d3e72358e28c.

technology, equipment, a competitive market, and transportation networks, coupled with blind investment and over exploitation, are the common challenges to economic development in China. Furthermore, a great number of enterprises entering the market at once might cause excessive production capacity, industrial structure imbalance, and uncontrolled environmental pollution. Additionally, the concerns related to land availability, lack of supply chains, and foundation facilities will bring more challenges to shale gas exploitation in China.

It remains to be seen what the implications will be in terms of environmental costs. Shale gas is obtained through hydraulic fracturing, a controversial extracting technology which creates, as highlighted by the shale gas boom that took place in the United States,[55] critical environmental threats, namely contamination of freshwater aquifers by fracturing fluids and depletion of local water supplies. In China, these obstacles to the mature development of the country's unconventional gas reserves are augmented by two deeply intertwined hurdles: the absence of a comprehensive legal framework specifically addressing the potential environmental hazards of shale gas production, and weak enforcement of relevant laws and regulations. Acknowledging the importance of shale gas as a bridging source of energy in the shift from fossil fuels to clean energy, the primary need is to minimize environmental damages related to the process of shale gas extraction and achieve the goal of extracting shale gas in an environmentally responsible way, which is mainly a matter of regulation and enforcement. In the last decade, the United States has taken the lead in exploration, development, technology, production, and export of shale gas. Consequentially the U.S. experience could be helpful for other countries, such as China, which wish to develop their own shale gas industries.

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55. Pulitzer Prize-winning energy author Daniel Yergin remarks how quickly natural gas from shale formations joined the energy mix in the United States: "Shale gas really has been a revolution that's happened extremely rapidly . . . . It's gone from being virtually none of our natural gas production to about 30 percent of our total natural gas production." YERGIN, *supra* note 26. S*ee also* Wiseman, *supra* note 7; Angela C. Cupas, *The Not-So-Safe Drinking Water Act: Why We Must Regulate Hydraulic Fracturing at the Federal Level*, 33 WM. & MARY ENVTL. L. & POL'Y REV. 605, 609–11 (2009).

II. CHINESE INSTITUTIONAL AND REGULATORY FRAMEWORK

The current Chinese regulatory framework lacks cohesive and satisfactory provisions regarding shale gas extraction and its related environmental concerns. There appears to be a generalized absence of cohesiveness in the energy-resources system, which is characterized by institutional fragmentation and conflicts of interest among a plethora of entities. The Chinese legal system features a tripartite structure: the National People's Committee passes laws; the State Council passes regulations; various ministries create rules; and departments within the ministries create other legislative documents. In the context of shale gas production, the Ministry of Environmental Protection (MEP) plays a fundamental role as it is responsible for enforcing environmental laws through its provincial and municipal subsidiaries. Another fundamental body is the National Development and Reform Commission (NDRC), which oversees the National Energy Administration and sets broad environmental standards and long-term goals that are regulated and enforced through provincial and municipal-level branches of the MEP.[56]

A. Regulation of the Shale Gas Industry in China

Regulation of the shale gas industry is horizontally fragmented and jointly undertaken by at least six authorities at the ministerial level, including the NDRC, Ministry of Land Resources (MLR), Ministry of Finance (MOF), MEP, Ministry of Science and Technology (MOST), and the State Administration of Taxation (SAT). The presence of many regulators carries the risk of conflict and makes the allocation of competences unclear. What emerges from an initial analysis is that the NDRC is in charge of shale gas industrial policies and planning, which covers targets, transportation, consumption, and pricing.[57] MLR is responsible for public tenders of shale gas blocks and the setting of thresholds for entry.[58] MOF and SAT jointly determine tax incentives, such as grants and preferential fiscal policies.[59] MOST works on improving and developing technolo-

56. ALBERT CHEN, AN INTRODUCTION TO THE LEGAL SYSTEM OF THE PEOPLE'S REPUBLIC OF CHINA (3d ed. 2004).

57. Lee, *supra* note 54.

58. *Id.*

59. *Id.*

gies for the Chinese geological environment, while MEP has strategic relevance as a supervisor and sets minimum standards for underground and surface water protection, wastewater treatment and recycling, air pollution, and protection of species of animals and plants.[60]

There are currently no Chinese laws that explicitly tackle the environmental risks of the fracking process. Moreover, although shale gas development is part of China's current Five-Year Strategic Plan, the Chinese government has neither passed legislation nor provided any guidance for shale gas exploration, market application, and strategic planning.[61] Despite this, several existing laws, if broadly interpreted, might be applied. However, these existing laws are neither exclusively concerned nor purposely drafted to deal with shale gas. In particular, the most pertinent law regarding shale gas production and its potential environmental perils is the Water Pollution Prevention and Control Law (WPPCL),[62] which sets central and local water standards to which local governments must adapt their regulations within a "cooperative federalism" framework.[63] This legal tool provides a number of measures aimed at protecting drinking water[64] and forbidding the construction of drainage outlets in specific areas. Article 38 of the Water Law lays down that "protective measures shall be taken . . . while constructing underground engineering facilities or carrying out underground prospecting, mining, and other underground ac-

60. *Id.*

61. For text in English of the Energy and Climate Goals of China's 12th Five-Year Plan, see Joanna Lewis, Pew Ctr. on Glob. Climate Change, *Energy and Climate Goals of China's 12th Five-Year Plan* (Mar. 2011), http://www.c2es.org/docUploads/energy-climate-goals-china-twelfth-five-year-plan.pdf.

62. Law on Prevention and Control of Water Pollution (promulgated by the Standing Comm. Nat'l People's Cong., May 11, 1984, amended Feb. 28, 2008). Another law that could come into play in this context is the Water and Soil Conservation Law. On this point see, Nengye Liu, *People's Republic of China: Water and Soil Conservation Law,* 1 IUCN ACAD. ENVTL. L. E-JOURNAL 69 (2012), http://ssrn.com/abstract=2040619.

63. Elizabeth Burleson, *Cooperative Federalism and Hydraulic Fracturing: A Human Right to a Clean Environment,* 22 CORNELL J.L. & PUB. POL'Y 289 (2013); *see also,* Jody Freeman, *Network Federalism* (2013), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2356380.

64. Law on Prevention and Control of Water Pollution, *supra* note 62, art. 56.

tivities."[65] The expression "other underground activities" certainly includes the fracturing process. Furthermore, the Water Law prohibits the discharge of a number of chemicals usually used in American fracturing fluids,[66] while allowed pollutant discharges are capped at fixed amounts.[67]

Although the WPPCL constitutes a fundamental tool in relation to the issues analyzed in this article, its coverage is still limited. While it requires that the State establish and improve compensation mechanisms for ecological protection of the water environment in drinking water source areas and reservoirs by instruments such as payment of transfers, no supporting laws and regulations currently exist.[68] Furthermore, the WPPCL contains some ambiguous provisions and lacks any definition of the authority of the local governments, creating a vacuum that frustrates the effectiveness of the regulatory framework.[69] The WPPCL permits the governments of provinces, autonomous regions, and municipalities to establish their own standards for items not set by a central body, and includes strong punitive measures to be imposed upon violators who can be fined and ordered to remediate the damage they have caused.[70] In particular, in the amended WPPCL promulgated in February 2008 and effective on June 1, 2008, stricter penalties against violators were added to enhance law enforcement.[71] Nevertheless, without detailed guidelines for implementing the law, effective enforcement of those stricter penalties remains unfulfilled.

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65. *Id.* art. 38.

66. Such chemicals include "any oil, acid, or alkaline solutions or highly toxic liquid waste" or "any highly toxic soluble waste residue containing mercury, cadmium, arsenic, chromium, lead, cyanide, etc." *Id.* arts. 29, 31.

67. *Id.* art. 18.

68. RESEARCH HANDBOOK ON CHINESE ENVIRONMENTAL LAW 72 (Tianbao Qin ed., 2015).

69. On the authority of local governments on environmental issues in China, see Alex Wang, *The Search for Sustainable Legitimacy: Environmental Law and Bureaucracy in China*, 37 HARV. ENVTL. L.R. 365, 429 (2013).

70. Law on Prevention and Control of Water Pollution, *supra* note 62, art. 13.

71. Jingyun Li & Jingjing Liu, *Quest for Clean Water: China's Newly Amended Water Pollution Control Law*, WILSON CTR. (July 7, 2009), https://www.wilsoncenter.org/publication/quest-for-clean-water-chinas-newly-amended-water-pollution-control-law#sthash.vaquLxby.dpuf.

Other relevant legal instruments are the Mineral Resources Law[72] and the Regulations of the People's Republic of China on Sino-foreign Cooperation in the Exploitation of Continental Petroleum Resources.[73] The former outlines a unified regional registration regime for the exploration of mineral resources, and is thus applicable to shale gas exploitation.[74] To obtain permission for exploration and extraction of minerals, a production plan must be submitted for approval by the Department of Geology and Mineral Resources. However, the qualifying criteria for approval are quite vague, and the law does not specifically define them.[75] On the other hand, the Regulations of the People's Republic of China on Sino-foreign Cooperation in the Exploitation of Continental Petroleum Resources targets the types of partnerships currently spreading in the exploration and production of unconventional gas.[76] The problem ap-

72. P.R.C. Law on Mineral Resources (promulgated by Order No. 36 of the President of the People's Republic of China, Mar. 19, 1986, effective Aug. 29, 1996).

73. Regulations of the People's Republic of China on the Exploitation of On-shore Petroleum Resources in Cooperation with Foreign Enterprises (promulgated by Decree No. 317 of the State Council of the People's Republic of China, Sept. 23, 2001, effective Sept. 23, 2001).

74. P.R.C. Law on Mineral Resources, *supra* note 72, art. 16.

75. The qualifying criteria for approval require adherence to: "qualifications prescribed by the State, and the department in charge of examination and approval shall, in accordance with law and relevant State regulations examine the enterprise's mining area, its mining design or mining plan, production and technological conditions and safety and environmental protection measures." *Id.* art. 15.

76. In particular, Article 13 states:

> To cooperate in the exploitation of on-shore resources, the Chinese petroleum companies and the foreign enterprise must enter into a contract. Unless laws, regulations or the contract specifies otherwise, the foreign enterprise entering into the contract (hereinafter referred to as the "foreign contractor") solely shall provide the investment for the exploration, be responsible for the exploration operations and bear all exploration risks. After the discovery of an oil (gas) field with commercial exploitation value, the foreign contractor and the Chinese petroleum companies shall jointly invest in cooperative development. The foreign contractor shall undertake the development and production operations, until production operations are taken over by Chinese petroleum companies as stipulated in the contract.

Regulations of the People's Republic of China on Exploitation of On-shore Petroleum Resources in Cooperation with Foreign Enterprises, art. 13. Lianyong Feng et al., *Developmental Features of the Chinese Petroleum Industry*

pears to be that there are potentially applicable domestic and regional laws but inadequate mechanisms for their implementation.

As for environmental law, despite the efforts made by China to craft a comprehensive environmental legal framework over the past thirty years, in practice, implementation has been notoriously poor.[77] Nevertheless, during China's 11th Five-Year Plan period (2006–10), bureaucrats started taking innovative action on environmental protection and energy efficiency, setting high priority, quantitative pollution reduction and energy efficiency performance targets that were assigned to governors, mayors, county magistrates, and State-owned enterprise leaders in every corner of China's massive bureaucracy. This new perspective derived from the prioritization of environmental protection through the "cadre evaluation system," i.e., China's system for top-down bureaucratic personnel evaluation.[78] As Alex L. Wang remarked, this evaluation framework is part of a far-reaching political strategy to limit risks to the party-state's hold on power.[79] In this vein, the cadre evaluation system fostered the use of environmental protection as an instrument for promoting the essential elements of China's "performance legitimacy," namely, sustained economic growth and social stability.[80] This shows how decentered the role of law in Chinese governance still is, and stresses the primary role of hierarchical structures and bureaucratic-plan targets.[81] Consequentially,

in Recent Years, *in* THE CHINESE OIL INDUSTRY: HISTORY AND FUTURE 17, 36–37 (Springer, 2013).

77. A leading Chinese environmental law scholar stated: "China's green laws are useless." Jin Wang, *China's Green Laws are Useless*, CHINA DIALOGUE (Sept. 23, 2010), http://www.chinadialogue.net/article/show/single/en/3831.

78. Wang, *supra* note 69, at 368, n. 13 ("'Cadres,' simply put, are party-state bureaucrats, which in the Chinese system include bureaucrats in State agencies and bureaus, state-owned enterprise workers, and staff in a range of other state institutions.").

79. *Id*. at 370.

80. *Id*.

81. Wang remarks,

> Bureaucratic mandates sit at the core of China's governance apparatus, leading the way. Despite years of official rhetoric on the development of Chinese rule of law, laws and regulations remain secondary. And their implementation is heavily influenced by whether they support or conflict with senior bureaucratic mandates. As a

Chinese leaders have relied mainly on top-down party-state bureaucratic mandates to drive performance of new environmental goals. At the same time, the cadre evaluation system represents an effort to promote (although haltingly) environmental values as a new source of legitimacy in line with the Hu-Wen rubric of a "harmonious society" as a programmatic response to concerns about declining State legitimacy.[82]

> practical matter, to understand Chinese governance we must understand this relationship between targets and law.

Id. at 372; *see also* Carl Minzner, *China's Turn Against Law*, 59 AM. J. COMP. L. 935, 949 (2011).

82. In the early 2000s, China's leadership spurred an internal debate on how to strengthen the legitimacy of China's regime. The debate mirrored concerns about the limits of regime legitimacy mainly relying on economic performance, and highlighted the need for "an ongoing shift from growth-centered performance to a post-growth mode of legitimation that incorporated social equality, justice, and welfare." Bruce Gilley & Heike Holbig, *The Debate on Party Legitimacy in China: a Mixed Quantitative/Qualitative Analysis*, 18 J. CONTEMP. CHINA 339, 339, 357 (2009). On February, 19, 2005, Chinese President Hu Jintao stressed the importance of developing the capacity to create a "harmonious society," i.e. a society based on democracy and rule of law, fairness and justice, honesty and friendliness, full of vigor, and a harmonious relationship between humans and nature. *See* Hu Jintao, *Building a Harmonious Society Important Task for CPC*, PEOPLE'S DAILY ONLINE (Feb. 21, 2005), http://en.people.cn/200502/20/eng20050220_174036.html; Paolo D. Farah, *EU and US Perspectives about China's Compliance with Transparency Commitments and the Transitional Review Mechanism*, 33 LEGAL ISSUES ECON. INTEGRATION, 263, 275 (2006). On the broader implications on global justice of environmental issues, see generally BENJAMIN K. SOVACOOL, MICHAEL H. DWORKIN, GLOBAL ENERGY JUSTICE (2014). Furthermore, the report to the 18th National Congress of the Communist Party of China stresses the importance of ecological civilization as a key element for the well-being of the Chinese people and the future of the country. The report also develops the concept of "Beautiful China," introducing a notion of development that emphasizes the strategic relevance of environmental protection even when this could be in conflict with energy security and economic development. Bruce Gilley and Heike Holbig argue that the Hu-Wen harmonious society represented a "programmatic solution to China's 'performance dilemma' and an innovative model of political legitimation." *Id.* On this point, see *Resolution on Strengthening the Construction of the Party's Governing Capacity*, approved by the 4th plenary session of the 16th CCP Central Committee (September 16–19, 2004), *available in Chinese at* http://www.people.com.cn/GB/shizheng/1026/2809350.html. The performance dilemma is the risk that autocratic rulers face undermining their own power if reforms that generate good economic performance lead to demands for greater political participation and democracy.

On more general terms, it can be said that there are two generations of Chinese "environmental" laws: the first focused on economic development, and the second on environmental protection. This parallels the general shift in U.S. legislation from pre-1960s laws to the new laws enacted from the 1960s through the 1980s.[83] The traditional Chinese environmental laws[84] focused on the development and use of natural resources by humans rather than the relationship between humans and nature,[85] whose ethical basis is to be found in the deep-rooted

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83. Christopher L. Bell et al., *Government Institutes*, *in* ENVIRONMENTAL LAW HANDBOOK (Thomas F. P. Sullivan ed., 21st ed. 2011); Brittany Dunton, *Recent Developments in Environmental Law*, 26 TUL. ENVTL. L.J. 147, 166, 175 (2012); Lisa Heinzerling, *New Directions in Environmental Law: A Climate of Possibility*, 35 HARV. ENVTL. L. REV. 263, 266–68 (2011); Linda K. Breggin et al., *Trends in Environmental Law Scholarship 2008-2012*, 43 ENVTL. L. REV. 10643 (2012); Amy J. Wildermuth, *Next Step: The Integration of Energy Law and Environmental Law,* 31 UTAH ENVTL. L. REV. 369, 380 (2011); Donald N. Zillman, *Evolution of Modern Energy Law: a Personal Retrospective,* 30 J. ENERGY & NAT. RESOURCES L. 485, 489–94 (2012); J. B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 343 (2010); VED P. NANDA & GEORGE ROCK PRING, INTERNATIONAL ENVIRONMENTAL LAW AND POLICY FOR THE 21ST CENTURY (2d revised ed. 2012); R. Daniel Kelemen & David Vogel, *Trading Places: The Role of the United States and the European Union in International Environmental Politics*, 43 COMP. POL. STUD. 427 (2010).

84. These laws include the Prevention and Control Atmospheric Pollution Act, the Prevention and Control of Water Pollution Act, the Prevention and Control of Solid Wastes Act, the Prevention and Control of Prevention from Environmental Noise Act, and the Prevention and Control of Radioactive Pollution Act. P.R.C. Law on the Prevention and Control of Atmospheric Pollution (promulgated by the President of the People's Republic of China, Apr. 29, 2000, effective Sept. 1, 2000) art. 1.; *see* P.R.C. Law on the Prevention and Control of Water Pollution, *supra* note 62; P.R.C. Law on the Prevention and Control of Envtl. Pollution by Solid Wastes (promulgated by Standing Comm. Nat'l People's Cong., Dec. 29, 2004, effective Apr. 1, 2005) art. 1.; P.R.C. Law on the Prevention and Control of Pollution From Envtl. Noise (promulgated by Standing Comm. Nat'l People's Cong., Oct. 29, 1996, effective Mar. 1, 1997) art. 1.; P.R.C. Law on Prevention and Control of Radioactive Pollution (promulgated by Standing Comm. Nat'l People's Cong., Jun. 28, 2003, effective Oct. 1, 2003) art. 1. *See also* Mingde Cao, *Fundamental Principles of Ecological Law*, 39 2002 U. WUHAN INT'L L. REV. 39 (2002).

85. Mingde points out that China's environmental and energy law and policy before 2000 was built upon the ethical basis of a narrow anthropocentrism, whose concept for legislation and tenet embodied the natural concept of utilitarianism. Mingde Cao, *The Current and Future Trends in Chinese Environmental and Energy Law and Policy*, 18 PACE INT'L L. REV. 253, 258 (2006).

concept of "harmonious nature."[86] These laws do not emphasize the prevention of environmental pollution but instead focus on remediation and passive reactions, and eventually risk disharmony and friction in the relationship between humans and nature. Conversely, the newest generation of Chinese environmental laws emphasizes the purpose of achieving harmony with nature and its conservation, rather than stressing economic growth. That said, recent Chinese environmental laws are substantially different from earlier legal instruments, as they foster the recycling economy and regulate clean processes of production,[87] focusing on minimizing pollution from the beginning through the end of the production process.

In the context of shale gas environmental hazards, two legal instruments come into play: the 2003 Law of the People's Republic of China on the Promotion of Clean Production,[88] and the 2002 Law of the People's Republic of China on Environ-

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86. Mingde Cao remarks that the concept of "harmonious nature" has a deep cultural root in China's traditional culture, and should be inherited and applied to today's environmental challenges. In that respect, Confucianism developed the principles that "nature and human beings understand each other," and of "nature and human beings combined into one." Regarding the relationship between humans and nature, Taoism preached noninterference and adaptation with the course of natural events. In the same vein, Buddhism advocated the right of natural life forms other than humans to exist. Mingde Cao & Yi-xiang Xu, *The Formulation of Chinese Civil Code and the Protection of Ecology*, 4 XIAN DAI FAXUE [Mod. L. Sci.] 13 (2003); *see also* Paolo D. Farah, *L'influenza della concezione confuciana sulla costruzione del sistema giuridico e politico cinese* [The Influence of Confucianism in the Construction of the Chinese Juridical and Political System], *in* IDENTITÀ EUROPEA E POLITICHE MIGRATORIE 193–226 (Giovanni Bombelli & Bruno Montanari eds., 2008); Jean-Yves Heurtebise, *Understanding Non-Trade Concerns Through Comparative Chinese and European Philosophy of Law*, *in* CHINA'S INFLUENCE ON NON-TRADE CONCERNS IN INTERNATIONAL ECONOMIC LAW (Paolo Davide Farah ed., forthcoming 2016).

87. "Clean production" is understood as a new industrial mode featuring technical plausibility, economic rationality and eco-efficiency, which is at the core of realizing a hazardless industry, i.e., production is organized in accordance with ecological principles, and raw materials are recycled in a closed cycle.

88. Law on the Promotion of Clean Production (promulgated by the Standing Comm. Nat'l People's Cong. June 29, 2002, effective January 1, 2003), 2003 - Order of the President of the People's Republic of China No. 72, as revised pursuant to the Decision of the Standing Committee of the National People's Congress on Revising the "Law of the People's Republic of China on Promotion of Cleaner Production" promulgated on February 29, 2012 - Order of the President of the People's Republic of China No. 54.

ment Impact Assessment.[89] The former specifically addresses pollution from oil and gas production, requiring that operators and subcontractors involved in petroleum production "protect fishery resources and other natural resources and prevent the environment, including the air, sea, rivers, lakes and land, from being polluted or damaged" through respect of international standards and best practices.[90] On the other hand, the 2002 Law on Environment Impact Assessment fosters a predictive evaluation policy on the environmental impact that may occur due to the implementation of building projects and planning. This regime is thus consistent with the purposes of sustainable development[91] and the principle of environmental law of "pollution prevention first."[92]

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89. Jesse L. Moorman & Zhang Ge, *Promoting and Strengthening Public Participation in China's Environmental Impact Assessment Process: Comparing China's EIA Law and U.S. NEPA*, 8 VT. J. ENVTL. L. 281, 282 (2007). Adopted in October 2002, the EIA became effective on September 1, 2003.

90. An indicative case study on enforcement is the benzene chemical spill of 2005 in the Junhgua River. Weili Duan et al., *The Situation of Hazardous Chemical Accidents in China Between 2000 and 2006,* 186 J. HAZARDOUS MATERIALS 1489 (2011). Jane Qiu, *China to Spend Billions Cleaning up Groundwater* SCIENCE 745, 745 (2011). Xiao Yong Wang et al., *Water Pollution Emergencies in China: Actualities, Prevention and Response,* 159 ADVANCED MATERIALS RES. 589 (2011).

91. This concept of "sustainable development" stems from the concept that individuals should respect and care for the community of life, recognize that all beings are interdependent, and that every form of life has value regardless of its worth to human beings. *See* Nicholas A. Robinson, *Enforcing Environmental Norms: Diplomatic and Judicial Approaches*, 26 HASTINGS INT'L & COMP. L. REV. 387, 387–89 (2003). As Chapin Folke, and Kofinas remarked, "social–ecological sustainability requires that society's economy and other human activities not exceed the capacity of ecosystems to provide services, which, in turn, is constrained by the planet's life-support system." F. Stuart Chapin, III, et al., *A Framework for Understanding Change*, *in* PRINCIPLES OF ECOSYSTEM STEWARDSHIP: RESILIENCE-BASED NATURAL RESOURCE MANAGEMENT IN A CHANGING WORLD 6 (F. Stuart Chapin, III, et al. eds, 2009). *See also* Doug M. Brown, *Market and Exchange in Premodern Economies*, in 2 ENCYCLOPEDIA OF POLITICAL ECONOMY 84–88 (Philip A. O'Hara ed., 2001).

92. On this principle, see James E. Hickey Jr. & Vern R. Walker, *Refining the Precautionary Principle in International Environmental Law,* 14 VA. ENVTL. L.J. 423 (1994); *Nicolas De Sadeleer, Environmental Principles: from Political Slogans to Legal Rules* (2002); David M. Driesen, *Cost-Benefit Analysis and the Precautionary Principle: Can They Be Reconciled,* 2013 MICH. ST. L. REV. 771 (2013).

B. Potential Regulations, Policies, and Protections for Hydraulic Fracturing

As a result, it would be advisable for jurisdictions in which hydraulic fracturing techniques are employed to first have gas companies conduct a thorough environmental impact assessment.[93] The shale gas drilling process can lead to land subsidence and earth vibrations, carrying with it civil liability for the oil operators who need to implement protective measures with a view to damage prevention.[94] If damage to protected interests—such as property, life, or the environment—occurs, compensation takes the form of restoration of the conditions as they existed before the damage occurred. In this regard, the liability regime established by the Chinese Civil Code, mining, and environmental legislation is applicable to any damage resulting from shale gas exploration and production activities. Moreover, Chinese lawmakers should also adopt and effectively enact legislation requiring water sampling near proposed well sites and a minimum liability insurance coverage for bodily injury and property damage caused by well operations.[95] Regarding the crucial value of assessment, Hannah Wiseman maintains that the assessment process is necessarily multifactorial and contingent, consequentially determining whether optimal regulation occurs at the state, regional, or national level is contingent on being able to assess accurately the risks associated with resource development.[96]

China undoubtedly has a number of laws that are able to guarantee the protection of its water supplies in the fracking process. Nonetheless, due to the general nontechnical content of environmental laws and the lack of risk assessment, they could be described as merely vague policy commitments rather than substantive, enforceable legal instruments. Several Chinese extraction laws could be relevant regarding shale gas production. However, they shape an inconsistent and fragmented

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93. The EIA should be topped by a seismological impact assessment on the geological impact of shale gas operations on the stability of earth at or near the well sites.

94. *Environmental and Social Risk Briefing Oil & Gas*, BARCLAYS (Mar. 2015), https://www.home.barclays/content/dam/barclayspublic/docs/Citizenship/oil-and-gas-guidance-note.pdf.

95. See the recently adopted legislation in Ohio on this point, S.B. 315.

96. Wiseman, *supra* note 7.

combination of regulations addressing other nontraditional extractive industries and government directives on extraction.[97] For instance, the Chinese policy on unconventional gas development and production partially reflects regulatory solutions adopted for methane extraction from coal seams (Coalbed Methane or CBM).[98] This would entail a series of import duty reductions or exemptions for technological imports that are used for shale gas exploration, exemptions from the payment of exploration and extraction rights, and also production subsidies.[99] The government is actually already referring to the policy developed for the CBM as a starting point to draft a policy related to shale gas,[100] especially regarding the environmental ap-

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97. In particular, regulations crafted by the MEP deal with issues related to emissions standards, surface draining systems, and restriction on gas emission in the environment. Moreover, regulations developed by the MLR outline the national policy on fees and royalties from mining prospects and other fiscal-related concerns, while standard price-sharing contracts require international energy enterprises to share large portions of their output with the government besides paying corporate taxes on profits. Finally, land rights and control of shale acreage are also governed by regulations issued by the MLR and not directly by national oil companies.

98. CBM is a methane gas that is extracted from the coal seams existing in some geological fields' subsoil. Dameng Yu et al., *A Review on Studies of Coalbed Methane Reservoirs in China,* 1 GEOLOGICAL SCI. & TECHN. INFO. 13 (2001); Qin Yong, *Advances and Reviews on Research of Coalbed Gas Geology in China,* 3 GEOLOGICAL J. CHINA U. 2 (2003).

99. In this context, one must also evaluate whether the World Trade Organization (WTO) Agreement on Subsidies and Countervailing Measures rules, especially Articles III and I that define the Agreement's sphere of application and subject, find a match in the energy sector. For an in-depth analysis of subsidies regulation within WTO legislation, see, in addition to the cited volumes and note 20, THE WORLD TRADE ORGANIZATION: LEGAL, ECONOMIC AND POLITICAL ANALYSIS 687–734 (Patrick F. J. Macrory et al. eds., 2005); JEFF WAINCYMER, WTO LITIGATION: PROCEDURAL ASPECTS OF FORMAL DISPUTE SETTLEMENT 765–69 (2002); R. K. GUPTA, ANTI-DUMPING AND COUNTERVAILING MEASURES: THE COMPLETE REFERENCE (1996); MICHAEL J. TREBILCOCK & ROBERT HOWSE, THE REGULATION OF INTERNATIONAL TRADE 268-73 (3rd ed. 2005); Alan O. Sykes, *The Economics of WTO Rules on Subsidies and Countervailing Measures* (John M. Olin Law & Economics Working Paper No. 186, 2003). *See also* VALERIE DI COMITE, LE SOVVENZIONI E LE MISURE COMPENSATIVE NELL'ORGANIZZAZIONE MONDIALE DEL COMMERCIO (2009); M. Orlandi, *La disciplina delle sovvenzioni concesse dagli Stati nella normativa OMC*, *in* QUADERNI DI STUDI EUROPEI. I SUSSIDI E GLI AIUTI DI STATO (2002).

100. Don Kun Luo et al., *Economic Evaluation Based Policy Analysis for Coalbed Methane Industry in China,* 36 ENERGY 360 (2011).

proach developed in the CBM area.[101] With regard to international cooperation policies, CBM exploration from foreign companies must occur pursuant to domestic laws regulating onshore oil resources in order to ensure a minimum standard of environmental protection, which should be enhanced in the shale gas field as well.[102]

The CBM legislation can also set an example with regard to the fiscal policy applied for energy companies involved in the unconventional gas production cycle. For example, every energy company operating in the CBM industry obtains a full refund of value-added tax.[103] Similarly, the equipment and instrumentation required for exploration and developing operations are free of duties, import taxes, and value-added tax.[104] Less onerous business income taxation is desirable as well. With regard to this, the Chinese government set the business income tax for independent national companies operating in the CBM industry at the favorable rate of 25 percent starting from 2008.[105] Likewise, domestic energy companies cooperating with foreign companies in the CBM industry benefit from a preferential fiscal policy, under which they are exempted from paying income tax for two years starting from the first income-accruing year. This mechanism might allow energy companies

101. Specifically, in July 2008, the MEP issued the Emission Standard of CBM/CMM regarding new mines and surface drainage systems.

102. Technology development in the shale gas exploration and exploitation field should be encouraged by the Chinese government as it already did in the 1983 National Programme on Research of Essential Technologies, through which the government incentivized the development of technologies related to CBM exploration and development. Baizhan Li & Runming Yao, *Urbanisation and its Impact on Building Energy Consumption and Efficiency in China*, 34 RENEWABLE ENERGY 1994 (2009). The development of innovative technologies in natural gas and oil exploration has been fostered also by the Mid-term and Long-term Scientific and Technological Programme (2006-2020). Fourth Globelics Conference in Mexico City, *Report by Shulin Gu et al. on China's System and Vision of Innovation: Analysis of the National Medium- and Long-term Science and Technology Development Plan for 2006–2020* (Sept. 22–24, 2008).

103. JANE NAKANO, DAVID PUMPHREY, ROBERT PRICE, JR. & MOLLY A. WATSON, PROSPECTS FOR SHALE GAS DEVELOPMENT IN ASIA EXAMINING POTENTIALS AND CHALLENGES IN CHINA AND INDIA 7 (2012), http://csis.org/files/publication/120911_Nakano_ProspectsShaleGas_Web.pdf.

104. *Id.*

105. *Id.*

to face the high unconventional gas production initial costs, therefore fostering investments and technological progress.

Given that the costs related to producing shale gas in China are higher than conventional gas, a subsidy policy is advisable in order to allow companies to join the sector. This technique has already been implemented by the MOF regarding energy companies involved in the CBM sector in China, which are entitled to a financial allowance of 0.02 renminbi per cubic meter when the gas is exploited locally, sold for domestic use, or used as a raw material for chemical processes.[106] To that end, the Chinese government has introduced subsidies for shale gas industry development, offering mining enterprises operating in the sector an allowance of 0.4 renminbi per cubic meter from 2012–2015, which is twice the amount provided for the CBM sector, though it has been observed that the allowance's short duration is not enough to draw foreign investment.[107] Also, pursuant to the *Foreign Investment Industrial Guidance Catalogue* (effective since January 30, 2012), foreign investments in the shale gas sector are subsumed under the "promotional" investment category, which allows foreign investors to form joint ventures—including contractual ones—with their Chinese partners.[108] Furthermore, equipment and technologies imported for

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106. Sino Gas & Energy, Developing Chinese Unconventional Gas Assets, Presentation to dbAccess China Conference 2014, at 17, http://sinogasenergy.com/wp-content/uploads/2014/12/2014-01_China_unconventional_gas.pdf (last visited Mar. 10, 2016).

107. *Id.*

108. NORTON ROSE FULBRIGHT, SHALE GAS HANDBOOK 53 (2013), http://www.nortonrosefulbright.com/files/norton-rose-fulbright-shale-gas-handbook-108992.pdf. *See* Catalogue of Encouraged Foreign Investment Industries, section

> II. Mining and Quarrying Industries: . . . (6) Prospecting and exploitation of such conventional oil resources as oil shale, oil sand, heavy oil and super heavy oil (limited to equity joint venture and contractual joint venture) . . . (9) Prospecting and exploitation of unconventional natural gas resources such as shale gas and submarine natural gas hydrate (limited to equity joint venture and contractual joint venture).

Catalogue for the Guidance of Foreign Investment Industries (Amended in 2011), MINISTRY OF COMMERCE PEOPLE'S REPUBLIC OF CHINA (Feb. 21, 2012, 2:51 PM), http://english.mofcom.gov.cn/article/policyrelease/aaa/201203/20120308027837.shtml.

exploration and development of the shale gas industry that are earmarked for that specific use and are not producible in China are free of duties and customs tariffs.[109]

III. ENVIRONMENTAL CONSIDERATIONS: FOCUS ON WATER RESOURCES MANAGEMENT

There are existing critical concerns about fresh water management in relation to unconventional gas.[110] These two natural resources have come to be complexly associated because the extraction, treatment, and distribution of fresh water entail considerable energy, while the production of fossil fuel energy involves fresh water.[111] Water concerns associated with unconventional fossil fuel extraction and production are augmented by growing demand from an increasing population and the influence of climate change on the hydrologic cycle.[112] Shale gas is a relatively clean and efficient burning fuel with the potential to lower carbon emissions. Nevertheless, risks remain, and the role of shale gas in the world's overall energy mix has been met with fierce opposition due to environmental concerns over hydraulic fracturing technology and its potential to cause environmental harm,[113] due to its shallower deposits, greater permeability, and more superficial formations.

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109. Desheng Hu & Shengqing Xu, *Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas,* 60 ENERGY POL'Y 21, 21–26 (2013). *See also* the new *Foreign Investment Industrial Guidance Catalogue* draft, the consultations of which closed on December 3, 2014.

110. A wider debate exists on the carbon footprint of unconventional gas. *See* Robert H. Abrams & Noah D. Hall, *Framing Water Policy in a Carbon Affected and Carbon Constrained Environment*, 50 NAT. RES. J. 3, 7 (2010).

111. As remarked by scholar Paula J. Schauwecker, "Water consumption and oil consumption are on a precariously parallel course." Paula J. Schauwecker, *Oil and Water: Fueling Questions*, 24 NAT. RESOURCES & ENV'T 46, 47 (2009).

112. Robert E. Beck, *Current Water Issues in Oil and Gas Development and Production: Will Water Control What Energy We Have?*, 49 WASHBURN L.J. 423, 424 (2010) (remarking that there are no fresh water alternatives, and water cannot be replaced). Consequentially, given the overlap between energy and water, both lawmakers and scientists must account for these interconnections, as they model and manage the hydrologic cycle.

113. The focus of this study on environmental aspects related to shale gas exploration and extraction should not render one oblivious of the other issues that may impact the development of global unconventional gas resources: fiscal conditions, landowner acceptance, interference from local authorities, pipeline and infrastructure issues, availability of technology, equipment and

Fracking involves drilling a well bore into a reservoir rock formation and then forcing water, sand, and chemicals into the well at high pressures to create fractures or fissures in the rock. Once the fracture is open, the released gas flows out of the fractures and into the well bore. In addition to shale gas, the process has recently been applied to extract gas from coal seams and tight sand deposits.[114]

These considerations mean that the extent to which shale gas becomes a larger element of the energy mix will depend on balancing environmental protection against economic growth. Some U.S. states and some EU countries, such as France, have already banned or imposed moratoria[115] on hydraulic fracturing due to environmental concerns[116] in attempts to harmonize environmental risks with energy security benefits. Conversely, China may opt for accepting greater environmental risks in order to bolster shale gas production and thus satisfy growing domestic energy demands, as well as create new jobs that full-scale production would generate, particularly for low-skilled workers.[117] However, bearing in mind the relevant geological factors, infrastructure challenges, and environmental hazards, it is one thing to find shale gas, and another to obtain commercially viable production from it.

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skilled labor force, and gas players' experience. *See, e.g.,* Susan L. Sakmar, *The Global Shale Gas Initiative: Will the United States Be the Role Model for the Development of Shale Gas Around the World?,* 33 HOUSTON J. INT'L L. 369 (2011).

114. NAHED TAHER, BANDAR AL-HAJJA, ENERGY AND ENVIRONMENT IN SAUDI ARABIA: CONCERNS & OPPORTUNITIES 139 (2013).

115. Moratoria represents a precautionary measure *par excellence*. ARIE TROUWBORST, PRECAUTIONARY RIGHTS AND DUTIES OF STATES 129 (2006). *See also* Jeffrey C. King, *Selected Re-Emerging and Emerging Trends in Oil and Gas Law as Result of Production from Shale Formations*, 18 TEX. WESLEYAN L. REV. 1, 2–3 (2011); Thomas Swartz, *Hydraulic Fracturing: Risks and Risk Management*, 26 NAT. RES. & ENV'T 30, 30 (2011).

116. The French Senate approved a ban on fracking in June 2011, as a result of extensive public protest. However, fracking is still permitted for scientific testing. *See* Ruven Fleming, *Shale Gas—A Comparison of European Moratoria*, 1 EUR. ENERGY & ENVTL. L. REV. 12 (2013).

117. In the United States, the shale gas industry has created six hundred thousand new jobs. Secretary of Energy Advisory Board, U.S. Dep't of Energy, *Shale Gas Production Subcommittee 90-Day Report* 1, 5 (Aug. 18, 2011), http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf. *See generally* Thomas C. Kinnaman, *The Economic Impact of Shale Gas Extraction: A Review of Existing Studies,* 70 ECOLOGICAL ECON. 1243 (2011).

As the creation of fracking fluid entails mixing of millions of gallons of fresh water with thousands of gallons of chemicals,[118] it is crucial to assess how harmful the fracking process might be to the environment.[119] First, hydraulic fracturing is supposedly responsible for a number of incidences of seismic activity, such as minor earthquakes and tremors. These seismic activities seem to be caused by either the fracking process itself or the injection of fracking wastewater into wells.[120] So far, there has been a more than a four-fold increase in earthquakes of magnitude three and greater in the central United States since 2008, that are "almost certainly" caused by fracking activities.[121] Similarly, in April and May 2011, shale gas exploratory drilling has been suspended in Lancashire, United Kingdom, following two earthquakes with magnitudes of 1.5 and 2.3.[122] A consequent report commissioned by the Cuadrilla Resources Ltd.,[123] the British company exploring for natural shale gas in

118. *See* Wes Deweese, *Fracturing Misconceptions: A History of Effective State Regulation, Groundwater Protection, and the Ill-Conceived FRAC Act*, 6 Okla. J. L. & Tech., no. 49, 2010, at 2. The EPA reports that hazardous fluids employed in fracking are often injected into shale formations at high volumes (a maximum average of 150,000 gallons per well, and a minimum average of 57,500 gallons per well). United States Envtl. Prot. Agency, *Final Report on Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs* 3–11 (June 2004) [hereinafter *EPA 2004*], https://fracfocus.org/sites/default/files/publications/evaluation_of_impacts_to_under-ground_sources_of_drinking_water_by_hydraulic_fracturing_of_coalbed_methane_reservoirs.pdf.

119. On the risks related to shale gas development, see generally Mark Zoback et al., *Addressing the Environmental Risks from Shale Gas Development*, (Worldwide Inst., Briefing Paper 1, 2010); Burleson, *supra* note 63, at 329. On the potential health hazards, see Michelle Bamberger & Robert E. Oswald, *Impacts of Gas Drilling on Human and Animal Health,* 22 *New Solutions: J. Envtl. & Occupational Health Pol'y* 51, 57–77 (2012).

120. Zoback, *supra* note 119, at 9.

121. Ajay Makan, *Fracking Water Linked to Earthquakes,* FIN. TIMES (Apr. 14, 2012, 1:28 AM), http://www.ft.com/intl/cms/s/0/e268a268-84f6-11e1-a3c5-00144feab49a.html#axzz2gMxH4mz3.

122. C. A. Green, P. Styles & B.J. Baptie, *Preese Hall Shale Gas Fracturing: Review and Recommendation for Induced Seismic Mitigation* 1 (2012), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/15745/5075-preese-hall-shale-gas-fracturing-review.pdf.

123. *Dep't of Energy and Climate Change (DECC), Fracking UK Shale: Understanding Earthquake Risk* 5 (2014),

the Bowland Basin in Lancashire, indicated that "it is highly probable that the hydraulic fracturing of Cuadrilla's Preese Hall-1 well did trigger a number of minor seismic events."[124] This of course has relevant implications for local residential and infrastructure damage. Seismic activity could also impact a well's integrity and cause further underground water contamination, as it could create leakages and new fractures, besides deforming well casings. Seismic activity can break or shear well casings as well, which is particularly dangerous in earthquake zones. This means that even if technical precautions to block off sensitive upper-level groundwater zones are taken, damaged casing could result in leaks, especially in environments physically under pressure. Moreover, Sichuan province, where most of the Chinese shale gas is located, is a region extremely prone to earthquakes; for example, the 2008 Great Sichuan Earthquake resulted in 69,195 deaths and over 18,300 missing.[125]

In addition to the risks related to seismic activities, principal concerns include groundwater contamination with fracking chemicals,[126] gasification,[127] water usage risks, surface water

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https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/283837/Seismic_v3.pdf.

124. *Press Release Geomechanical Study*, CUADRILLA RESOURCES (Feb. 11, 2011) http://www.cuadrillaresources.com/news/cuadrilla-news/article/press-release-geomechanical-study/.

125. Xinglin Lei et al., *A Detailed View of the Injection-Induced Seismicity in a Natural Gas Reservoir in Zigong, Southwestern Sichuan Basin, China,* 118 J. GEOPHYSICAL RES.: SOLID EARTH 4296 (2013); Michael Esposito, *Water Issues Set the Pace for Fracking Regulations and Global Shale Gas Extraction,* 22 TUL. J. INT'L & COMP. L. 167 (2013); Nicola Jones, *Wastewater Injection Cracks Open Quake Concerns,* 6 NATURE GEOSCIENCE 329, 329 (2013); William L. Ellsworth, *Injection-Induced Earthquakes,* SCIENCE, July 12, 2013; Bob Weinhold, *Energy Development Linked with Earthquakes,* 120 ENVTL. HEALTH PERSP. a388 (2012); Thomas W. Merrill, *Four Questions About Fracking*, 63 CASE W. RES. L. REV. 971 (2013).

126. Currently, China does not have a regulatory framework aimed at ensuring that wastewater injection into underground wells does not endanger groundwater. Such regulations would ensure that wastewater injection into underground wells, including injection of hazardous wastewater produced from hydraulic fracturing, would not endanger local water supplies. Lan Nan, *Legal Tools for Groundwater Protection: Insights from International Experience,* 8 CHINA J. NAT. RESOURCES ECON. 33–43 (2011).

127. When gas migrates into groundwater, the build-up of pressure due to gasification may lead to tremors or explosions. Aquifer gasification due to shale gas development has been cited as a potential cause for recent minor

and soil risks spills, and blow-outs. Conversely, environmentalists argue that, although hydraulic fracturing is believed to be less water intensive than nuclear energy and coal production, it is unlikely that it will replace either energy source.[128] Rather, shale gas development carries the danger of creating an additional demand for water. Shortage of water is one of the most crucial issues facing shale gas development in China, as water is a fundamental element in the fracking process. In the shale gas-rich Sichuan Basin, this is a primary concern due to the province's agricultural legacy that furnishes the country with roughly 7 percent of its rice, wheat, and other grains.[129] There are three possible outcomes for the water used during fracking: (1) it can be extracted, recycled, and used again; (2) it can be left inside of the shale deposit; or (3) it can be extracted and stored on or off site or treated for other uses.[130]

The use of recycled water for hydraulic operations is highly advisable, given the intense residential and industrial demand for water in Sichuan and water scarcity concerns in Xinjiang.[131] Regulations should also consider the possibility of establishing a closed-loop system of energy production, using mine-drainage

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seismic activity in the United Kingdom, though these claims are largely unproven at this point and are being investigated. *See* KPMG GLOB. ENERGY INST., *supra* note 51.

128. Bridget R. Scanlon et al., *Drought and the Water–Energy Nexus in Texas*, 8 ENVTL. RES. LETT. 1 (2013), http://iopscience.iop.org/article/10.1088/1748-9326/8/4/045033/pdf; Jean-Phillipe Nicot & Bridget R. Scanlon, *Water Use for Shale-Gas Production in Texas*, 46 ENVTL. SCI. TECH. 3580 (2012); Ian J. Laurenzi & Gilbert R. Jersey, *Life Cycle Greenhouse Gas Emissions and Freshwater Consumption of Marcellus Shale Gas*, 47 ENVTL. SCI. TECH. 4896 (2013).

129. Joel Kirkland, *China Begins to Tap Its Shale Gas, Despite Daunting Technological, Environmental Hurdles*, N.Y. TIMES, Oct. 14, 2011, http://www.nytimes.com/cwire/2011/10/14/14climatewire-china-begins-to-tap-its-shale-gas-despite-da-95706.html?pagewanted=all

130. Deweese, *supra* note 118, at 19. Schauwecker, *supra* note 111, at 47. Gas drillers are experimenting with new technologies and methods empowering them to be more effective at recycling fracking water. See the use of "mobile heated distillation units" by Devon Energy Corporation as an example of emerging efficiencies. *See* Laura C. Reeder, *Creating a Legal Framework for Regulation of Natural Gas Extraction from the Marcellus Shale Formation*, 34 WM. & MARY ENVT'L L. & POL'Y REV. 999, 1013 (2010).

131. Zmarak Shalizi, *Addressing China's Growing Water Shortages and Associated Social and Environmental Consequences* 6 (World Bank, Policy Res. Working Paper No. 3895, 2006), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=923238.

water from coal production (after having neutralized and removed heavy metals), thus integrating industrial ecology practices into the fracking process. However, this practice should only be implemented after groundwater regulations are strengthened, and after China has gained substantial experience in minimizing pollution from fracturing operations, while also ensuring the proper disposal of the heavy-metal waste products from treating these industrial water sources.[132]

Water is an especially urgent issue for China as its per capita availability of drinking water is very low, and water resources are not well distributed throughout the country.[133] Diverging water supplies from agriculture to shale gas production could be catastrophic, in particular if the contaminated water also pollutes farmlands. Conversely, for other shale gas basins in Tarim, Xinjiang, and Inner Mongolia, the scarcity of water is aggravated by the arid and hot climate. Shale gas exploration and production would thus require water to be carried from other parts of the country, which would raise costs unsustainably and impact the environment. Furthermore, climate change and China's rapid economic development have led to an increase in industrial and agricultural water consumption, while areas of desertification are expanding, deteriorating the ecological environment which is already overexploited.[134] In China, water availability for hydraulic fracturing may significantly reduce the prospective for national shale development in certain areas. Figure 1 draws attention to these potential water

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132. For example, in November 2011, the Pennsylvania Department of Environmental Protection released a statement encouraging the oil and gas industry to utilize recycled mine drainage water in hydraulic fracturing. Pennsylvania Dep't of Envtl. Prot., *DEP Effort Encourages Oil and Gas Industry to Use Mine Drainage Water* (Nov. 18, 2011), http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=19161&typeid=1.

133. Roberto Soprano, *China and the Recognition and Protection of the Human Right to Water*, *in* CHINA'S INFLUENCE ON NON-TRADE CONCERNS IN INTERNATIONAL ECONOMIC LAW (Paolo Davide Farah & Elena Cima ed., forthcoming 2016).

134. On desertification and water management in China, see CI LONGJUN & XAIOHUI WANG, DESERTIFICATION AND ITS CONTROL IN CHINA (2010). There is clearly tension between economic self-sufficiency in agriculture and in energy. Mark Harvey, & Sarah Pilgrim, *The New Competition for Land: Food, Energy, and Climate Change*, 36 FOOD POL'Y 1 (2011); Jörg Friedrichs, *Global Energy Crunch: How Different Parts of the World Would React to a Peak Oil Scenario,* 38 ENERGY POL'Y 4562, 4562–69 (2010).

scarcity issues in China, which are likely to make the costs of shale development exorbitant.

Figure 2. China Shale Resource and Water Stress Map. Map replicated from "Natural Gas Weekly Kaleidoscope," Barclay's Capital Commodities Research (November 16, 2010).

A. Implementation and Enforcement of Energy and Environmental Laws: Fragmentation of Competences

China's poor law enforcement has undermined the efficacy of past efforts. In particular, China features a highly fragmented water-resources management system. Horizontally, several institutions are involved at every level of government. At the central level, the National People's Congress and State Council enact laws and administrative regulations and supervise their local implementation and enforcement. Additionally, several ministries and authorities are responsible in different ways in water management.[135]

135. The Ministry of Water Resources, which is a leading agency for integrated water resource management, water resource protection planning, water function zoning, monitoring water quantity, and quality in rivers and lakes, issues water resource extraction permits and proposes water pricing

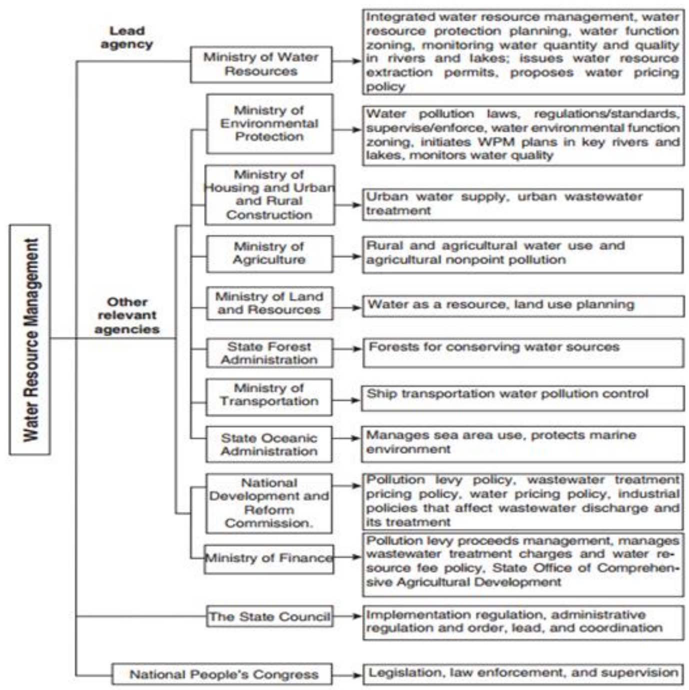

Figure 3. Water management competences allocation in China (Xie, Jian; Liebenthal, Andres; Warford, Jeremy J., *Addressing China's Water Scarcity: A Synthesis of Recommendations for Selected Water Resource Management Issues*, 2008, World Bank Publications).

This unwieldy regime carries the risks of creating both overlaps and friction in responsibility, as the lines of demarcation between institutional jurisdictions and competences are not

policy; the MEP, specifically competent for water pollution laws, regulations and standards supervision and enforcement, and monitoring of water quality; the Ministry of Housing and Urban and Rural Construction; the Ministry of Agriculture; the Ministry of Land and Resources; the State Forest Administration; the Ministry of Transportation; the State Oceanic Administration; the NDRC; and the MOF. A common expression to describe the current system is that "nine dragons" manage the water. *See* JIAN XIE ET AL., ADDRESSING CHINA'S WATER SCARCITY 30 (2009); Jiang Yong, *China's Water Scarcity,* 90 J. ENVTL. MGMT. 3185, 3190–91 (2009). Wang Xinbo, *Water Governance in China: The Failure of a Top-Down Approach*, *in* THE WATER REVOLUTION: PRACTICAL SOLUTIONS TO WATER SCARCITY 149–71 (Barun Mitra et al. eds., 2006); Yan Feng et al., *Water Resources Administration Institution in China,* 8 WATER POL'Y 291 (2006).

always clear. Even the responsibility for water pollution prevention and control, which should be a fundamental step in the shale gas extraction process, is distributed to different governmental bodies. Vertically, the water-management regime features similar fragmentation, and relies on unclear administrative boundaries linked to different levels of government. Finally, the political friction and informational asymmetry between central and local governments block more meaningful cohesive action. The absence of an overarching energy law causes overlaps and contentious bureaucratic infighting that have a detrimental effect on the ability to face long-term energy challenges. In fact, not just water management but energy governance as a whole has been decentralized during the course of several rounds of administrative reorganizations, dispersing and scattering the country's decentralized energy authority among parallel central ministries.[136]

It remains to be seen what the implications will be for shale gas industry expansion in China, whether this fragmentation will further hamper its development or whether these challenges will be adequately met by a more integrated system, inspired, for instance, by the water-resource management systems of France and the United Kingdom.[137] Given the fact that in China levels of pollution from industry and agriculture are dangerously high, shale gas should be developed and extracted relying on a regulatory and institutional framework capable of reducing any related environmental hazards, striking a balance between energy security benefits and environmental costs, in order to guarantee the right to water universally.[138] The

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136. Bo Kong, *Governing China's Energy in the Context of Global Governance*, 2 GLOBAL POL'Y (SPECIAL ISSUE) 51, 52–63 (2011).

137. Those water-resource management systems specifically aim at ensuring the security of water supplies, protecting ecological resources of the water environment, and improving the efficiency of local water supply and wastewater treatment. Those regulatory objectives are achieved through different instruments, inter alia, consensual agreements among all stakeholders and technical advice. The financial resources originated from water pricing and the enforcement of the consumer-pays principle for quantitative management and the polluter-pays principle for pollution control. *Id.*

138. Recognition of the right to water has been debated in a number of international law *fora.* The right to water is a crucial element in the work of the Human Rights Council, the U.N. General Assembly, many scholars, and nongovernmental organizations (NGOs). In September 2010, a resolution adopted by consensus by the Human Rights Council affirmed that the right to

recognition of such a right would be a first good step, but should be followed by effective policy implementation and enforcement.[139]

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water and sanitation is recognized in existing international law. *See* Human Rights Council Res. 15/L.14, U.N. Doc. A/HRC/15/L.14 (Sept. 24, 2010). In 2010, China voted in favor of a U.N. General Assembly resolution recognizing the right to water as a human right. G.A. Res. 64/292, The Human Right to Water and Sanitation (Aug. 3, 2010). This Resolution acknowledges that clean drinking water and sanitation are integral to the realization of all human rights. Accordingly, the right to water imposes a burden on China to develop new policies and rules to ensure safe drinking water for its population. However, the resolution does not have a legally binding effect, and is generally regarded as a soft law legal instrument. The vote in favor of the U.N. General Assembly resolution is an important first step, but China should pursue formal recognition of the right to water in international and domestic laws in order to grant its citizens legal entitlement against the state in case of serious interferences with the enjoyment of the right to water, which requires the state to adopt, inter alia, effective legislation to restrain third parties from polluting water resources. Jade Harsha*, Conflicts and Dilemma of Human Right to Water,* 100 CURRENT SCI. 1178, 1778 (2011). It is nevertheless uncertain what incentives China has to take such a step, and whether this scenario is plausible at all. In fact in China new regulations have been adopted to protect the environment, but lack of control and enforcement measures remains a crucial problem. Recognition of the right to water within the national political and legal systems by way of legislative implementation would constitute a step in the right direction, but it should be accompanied by monitoring and enforcement measures. The right to water is not recognized at the constitutional level in China. Article 9 of the Constitution of the People's Republic of China [*Zhonghua Renmin Gongheguo Xianfa, Di Jiu Tiao*] states:

> mineral resources, waters, forests, mountains, grassland, unreclaimed land, beaches and other natural resources are owned by the State, that is, by the whole people, with the exception of the forests, mountains, grasslands, unclaimed land, and beaches that are owned by collectivities in accordance with the law. The State ensures the rational use of natural resources and protects rare animals and plants. The appropriation or damage of natural resources by any organization or individual by whatever means is prohibited.

As previously mentioned, provisions on supply and sanitation are included in secondary resources, inter alia, P.R.C. Law on Prevention and Control of Water Pollution, *supra* note 62. William C. Jones, *The Constitution of the People's Republic of China*, 63 WASH. U. L.Q. 707 (1985).

139. Peter Gleick, *China and Water*, *in* THE WORLD'S WATER: THE BIENNIAL REPORT ON FRESHWATER RESOURCES 79, 94-95 (Peter H. Gleick et al. eds., 2008).

Many factors contributed to the currently weak enforcement of environmental regulations in China. The breakthrough of shale gas exploration and production in China is undermined by the country's unsatisfactory record on environmental enforcement, which jeopardizes the capacity of existing laws to both prevent and minimize the downsides of hydraulic fracturing.[140] China relies on a multilevel system of authority based on central supervision of local governments to guarantee adequate legal enforcement. Environmental regulations are accordingly enforced at the local level through central Government Regional Supervision Centers ("RSCs") and local governments' Environmental Protection Bureaus, which are responsible for supervising the implementation of central laws, investigating major pollution events, coordinating and settling transboundary environmental disputes, and receiving and responding to complaints.[141] However, the efficiency of the government RSCs is weakened by several constraints. The RSCs are extremely underfunded, which results in weak governmental enforcement capacity, and are financed by local governments, causing conflicts of interest, corruption, and complicity.[142] Moreover, the RSCs lack enforcement authority over local government Environmental Protection Bureaus. To overcome these hindrances, the RSC's role should be reinforced by providing specific legal tools and conferring to the centers more adequate funding and greater powers.

B. Transparency and Disclosure about Fracking Activities: Evaluating the Chinese and U.S. Approaches

Other factors not limited to the area of water pollution control and prevention contribute to current weak law enforcement in China. In particular, the existing legal instruments lack enforcement mechanisms and procedures, namely supervision, monitoring, reporting, and evaluation. The enforcement of environmental laws could be improved through legal instruments that facilitate access of the general public to information and statistics in order to foster a positive feedback mechanism

140. *See generally* Wang, *supra* note 69.
141. Scott Moore, *Commentary: Shifting Power in Central-Local Environmental Governance in China: The Regional Supervision Centers*, 11 CHINA ENV'T SERIES 188, 188 (2011).
142. *Id.* at 191.

that could exercise greater pressure on local or central government to enforce existing regulations.[143]

These transparency measures have already contributed to filling the gap between central and regional regulations for the oil industry in both the United States and China. In 1986, the United States adopted the Emergency Planning and Right to Know Act (EPCRA),[144] which fosters and promotes emergency preparedness by asking local and federal governments to publicize precise information about the presence of potential chemical risks.[145] Similarly, the Environmental Protection Agency's (EPA) Toxic Release Inventory ("TRI")[146] maintains a searchable database of toxic chemical releases and waste-management activities whose aim is to inform and guide policy decisions of local communities and federal government, enhancing participatory mechanisms. However, U.S. shale gas companies are not required by federal law to disclose the chemicals being used for hydraulic fracturing. Although to date, eleven states have passed laws requiring drilling companies to reveal some, though not all, of the chemicals they use. The U.S. Groundwater Protection Council and Department of Energy (DOE) have also developed a web-based national registry called "FracFocus," which allows the public to access information, on a well-by-well basis, on chemical constituents used in hydraulic fracturing.[147] Moreover in some states, such as Texas[148] and Colo-

143. Ma Jun, *The Power of Public Disclosure*, CHINA DIALOGUE (Dec. 13, 2010) https://www.chinadialogue.net/article/show/single/en/4001-The-power-of-public-disclosure.

144. Emergency Planning and Community Right-to-Know Act (EPCRA), 40 C.F.R. §§ 355, 370, 372 (2015); EPCRA: Section 313, E.P.A. Doc. 260/K-010001 (Feb. 2001).

145. EPCRA §§ 311–12 (2011).

146. TRI was established in 1986 by the EPCRA. In 1990, Congress passed the Pollution Prevention Act (PPA), which required that facilities report additional data on waste management and source reduction activities under TRI. The TRI-specific sections of these two laws are Section 313 of the EPCRA and Section 6607 of the PPA. *Toxic Release Inventory Program*, UNITED STATES ENVTL. PROT. AGENCY, http://www.epa.gov/toxics-release-inventory-tri-program (last updated Mar. 14, 2016).

147. On the role of FracFocus and its implications, see generally Leah A. Dundon, Mark Abkowitz & Janey Camp, *The Real Value of FracFocus as a Regulatory Tool: A National Survey of State Regulators*, 87 ENERGY POL'Y 496 (2015); Katherine Konschnik & Archana Dayalu, *Hydraulic Fracturing Chemicals Reporting: Analysis of Available Data and Recommendations for Policymakers*, 88 ENERGY POL'Y 504 (2016).

rado,[149] disclosure on FracFocus is a mandatory legislative requirement. The case against mandating the disclosure of hydraulic fracturing chemicals is that "[t]he specific make-up of the chemicals used in fracturing in particular is considered proprietary information and should be protected."[150] Conversely, it should be kept in mind that considerable knowledge gaps about the effects of hydraulic fracturing on water, hence public health, still exist.

One embryonic tendency in the United States is that shale gas operators are starting to voluntarily publish the chemicals employed in their hydraulic fracturing processes. For instance, Aubrey McClendon (Former President and Chief Executive Officer of Chesapeake Energy) and John Pinkerton (Chairman and Chief Executive Officer of Range Resources Inc.) have specified that their companies will make publicly available a list of chemicals used.[151] In 2009, in regards to legislative responses, the Fracturing Responsibility and Awareness of Chemicals Act (FRAC Act) was proposed in attempts to close the loophole exempting companies drilling for natural gas from disclosing the chemicals involved in fracking operations that would normally be required under federal clean water laws.[152] An attempt was made to introduce the FRAC Act in 2009, and on March 15, 2011, U.S. Representatives Diana DeGette and Jared Polis reintroduced it to Congress.[153] Congress had not yet passed either

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148. The Texas legislature enacted legislation in mid-2011 that directed the Texas Railroad Commission (which regulates oil and gas activity in Texas) to draft regulations that require companies to disclose fracturing fluid composition on a well-by-well basis by posting information on FracFocus. The Commission complied with the directive, enacting such regulations in December 2011. *See* TEX. NAT. RES. CODE ANN. § 91.851(a)(1)(A) (West 2012). 75; TEX. ADMIN. CODE § 3.29 (2012).

149. COLO. CODE REGS. § 404-1:205A (2012).

150. Deweese, *supra* note 118, at 11.

151. *Id*. at 12–13; *see also* Timothy Gardner & Sarah N. Lynch, *Despite Probe, SEC Says Not Regulating Fracking*, REUTERS (Sept. 15, 2011, 3:58 PM), http://www.reuters.com/article/2011/09/15/us-usasec-fracking-idUSTRE78E5NK20110915.

152. On the FRAC Act, see generally SUSAN L. SAKMAR, ENERGY FOR THE 21ST CENTURY: OPPORTUNITIES AND CHALLENGES FOR LIQUEFIED NATURAL GAS (LNG) 316 (2013).

153. David O. Williams, *DeGette, Polis Once Again Introduce FRAC Act to Bring Federal Oversight to Gas Fracking*, COLO. INDEP. (Mar. 15, 2011, 5:47 PM), http://coloradoindependent.com/79273/degettepolis-once-again-introduce-frac-act-to-bring-federal-oversight-to-gas-fracking.

of the FRAC Act bills. This bill was reassigned as number S. 785 to a congressional committee on March 18, 2015, which will consider the bill before possibly sending it on to the House or Senate as a whole.[154]

In China, transparency initiatives are growing in order to tackle information shortcomings. The Water Law[155] requires the environmental protection administration departments of the local people's governments to periodically disclose pollution quantity control targets.[156] This legal tool also requires the Environmental Protection Administration Department of the State Council and local governments to "name and shame" local governments[157] who fail to meet their quantity control targets.[158] The first ministry-level disclosure law is the Measures on Open Environmental Information (for Trial Implementation) was passed on February 8, 2007, by the MEP in order to foster public participation in fighting pollution.[159] The measures require companies to timely and accurately disclose their environmental information[160] and promote citizen involvement, in that "citizens, legal persons and other organiza-

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154. Fracturing Responsibility and Awareness of Chemicals (FRAC) Act, S. 785, https://www.govtrack.us/congress/bills/114/s785.

155. *See* P.R.C. Law on Prevention and Control of Water Pollution, *supra* note 62.

156. *Id.* art. 19.

157. Even before the Water Law was approved, some laws fostering transparency and public participation had been adopted, such as the Clean Production Law of 2003, which required emissions and other environmental data. Furthermore, the Environmental Impact Assessment Law of 2003 requires partial public disclosure of the environmental impact assessments completed for permit applications. P.R.C. Law on Environmental Impact Assessment (promulgated by Order No. 77 of the President of the People's Republic of China, Oct. 28, 2002, effective Sept. 1, 2003).

158. *Id.*

159. Measures on Open Environmental Information (for Trial Implementation) (adopted by the State Environmental Protection Administration of China, Feb. 8, 2007, effective May 1, 2008).

160. Article 4 provides:

> Environmental protection departments shall observe the principles of justice, fairness, convenience to the people and objectivity and disclose government environmental information promptly and accurately. Enterprises shall disclose enterprise environmental information promptly and accurately under the principle of combining voluntary disclosure with mandatory disclosure.

Id. art. 4.

tions" are allowed to "ask environmental protection departments to obtain government environmental information."[161]

Despite the progress made by Chinese local governments regarding transparency and disclosure of environmental information, differences among provinces and regions remain. In particular, disclosure of the environmental impact by large energy companies is limited, and, being big taxpayers, the government generally sits by when they refuse to disclose their environmental information. Another hurdle is related to the normative nature of these regulations, which do not usually impose mandatory environmental disclosure requirements on enterprises, but merely encourage companies to take their own initiative in providing information.

Environmental disclosure and transparency directly affect social acceptance, which is a key element for the long-term success of shale gas development, as previous North American experience shows.[162] It is crucial to developing mutual-trust and mutual-benefit relations between the shale gas industry and local communities. This would minimize the social risk for the developer, while involving the community in the decision-making process, and ensuring tangible and equitable benefits from the project. In this vein, strong transparency initiatives and mandatory disclosure of environmental information represents a crucial step towards safer regulation of shale gas development and better enforcement of domestic environmental laws.

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161. *Id*. art. 5.

162. On this point, see Eleanor Bayley, *Conflict Sensitivity of the Shale Gas Industry*, NEWCLIMATEFORPEACE.ORG, (Sept. 17, 2015), https://www.newclimateforpeace.org/blog/nrm-and-conflict-%E2%80%93-conflict-sensitivity-shale-gas-industry. Bayley states,

> Where there is a lack of disclosure from companies over policies and plans for meeting environmental standards and strong opposition from environmental groups, coupled with only nascent independent research and analysis on the environmental impacts of fracking and strong national and international anti-fracking campaigns can result in mis-information, thus clouding effective discussion and contributing to company-community misunderstanding and conflict.

Id.

IV. COMPARATIVE ANALYSIS WITH THE PREVIOUS EXPERIENCE OF THE UNITED STATES: A MODEL OF DEVELOPMENT FOR THE UNCONVENTIONAL GAS MARKET?

Although there are clear differences between China and the United States in the context of shale gas, further analysis reveals important similarities. Shale gas is a pivotal factor for the future of energy in both countries, where energy security, energy efficiency, and environmental concerns are deeply intertwined. These two countries strive to guarantee greater energy security by boosting domestic resources.[163] Additionally, their regulatory frameworks share similarities, as both have far-reaching federal or central laws enforced by designated agencies. Furthermore, both countries exhibit a gap between the formulation of federal or central law and their enforcement at the local level. These similarities between the U.S. and Chinese energy systems allow for the drawing of parallels that could be beneficial to the Chinese shale gas industry.[164]

For the purposes of this article, it is useful to analyze the factors that allowed the United States to trigger what is called the "shale revolution."[165] Shale gas industry development has deeply altered the U.S. energy scenario, allowing the transition from energy shortage to energy abundance, and the country—globally at the top of the list for energy consumption—could

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163. *See generally* INT'L ENERGY AGENCY, WORLD ENERGY OUTLOOK SPECIAL REPORT: ENERGY AND CLIMATE CHANGE (2015), https://www.iea.org/publications/freepublications/publication/weo-2015-special-report-energy-climate-change.html.

164. However, the two countries have different geological characteristics. Hydraulic fracturing in China is much more geographically challenging than it is in the United States, mainly because Chinese shale gas is found in much rougher and deeper terrain than U.S. shale gas. Hence, the expertise derived from the U.S. shale industry may not be directly adaptable to China, as it would demand more experienced staff, supplementary equipment, technological innovation and augmented costs. Additionally, the quality of the shale rock and gas in China is also different than that in the United States, as it is more difficult to be fractured and contains much more non-hydrocarbon gasses. This means that Chinese shale gas is of a lower quality, and consequentially may be costly in the long-term, as China may be compelled to define ways to render the gas more usable. *See generally*, Liu Honglin, *The Drilling and Completion Technology of Shale Gas and Its Status Reservoir Stimulation Technology in Foreign, and Our Adaptive Analysis*, *in* SENIOR SYMPOSIUM OF NATIONAL OIL AND GAS WELL ENGINEERING SCIENTIFIC RESEARCH PROGRESS AND DRILLING ENGINEERING TECHNOLOGY (2009) (in Chinese).

165. STEVENS, *supra* note 17.

soon become the main hydrocarbon producer.[166] Shale gas is already influencing global energy relationships by replacing oil in the new global energy balance, and its impact will be even clearer when its first export starts in 2017.[167] In the United States there are many liquefied natural gas ("LNG") platforms, which originally were built to import gas but are now being converted for shale gas export, if possible towards Europe, India, and China. This shift aimed to widen the political and commercial sphere of influence of the United States in global energy safety and related geopolitical relationships, as well as for reducing the near Russian and Middle Eastern monopoly in the natural gas industry.[168] The shale gas revolution has altered hydrocarbon-production economic assets in the United States, reducing dependency on imports and strengthening the domestic manufacturing sector, thanks to reduced energy costs.[169] It is therefore useful to analyze the factors that have

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166. MARY LASHLEY BARCELLA & DAVID HOBBS, IHS CERA, FUELING NORTH AMERICA'S ENERGY FUTURE, at I-6 (2009). *See also* John Deutch, *The Good News about Gas-The Natural Gas Revolution and Its Consequences*, 90 FOREIGN AFF. 82 (2011); John Deutch, *The US Natural-Gas Boom Will Transform the World*, WALL ST. J. (Aug. 14, 2012, 6:53 PM), http://www.wsj.com/articles/SB10001424052702303343404577514622469426012. As a consequence of the shale gas revolution, the North American gas basin, currently estimable at 3–400 billion cubic feet, could bear current energy consumption for more than one-hundred years. *See* Yergin, *supra* note 26, at 332.

167. Cuckoo Paul, *Will Shale Gas Trigger a New World Order?*, FORBES INDIA (Aug. 5, 2013), http://forbesindia.com/blog/business-strategy/will-shale-gas-trigger-a-new-world-order/#ixzz3xo2MwosF.

168. James T. Jensen, Presentation to the Paris Energy Club: LNG Exports from North America: How Competitive Are They Likely to Be? (May 4, 2012).

169. Starting in 2007, the increase in domestic gas production has led to a significant gas surplus that demand could not completely absorb. As has been observed by the U.S. Energy Information Agency in its 2013 Annual Outlook on Energy:

> The US Energy Information Agency . . . forecasts that natural gas production in the United States will grow from 23 billions of cubic feet in 2011 to 33.1 billions of cubic feet in 2040, with a 44% increase. Almost the entirety of this increase in domestic natural gas production is due to the forecast boost in shale gas production, that will switch from 7.8 billions of cubic feet in 2011 to 16.7 billions of cubic feet in 2040.

influenced U.S. policies on unconventional gas. Shale gas industry development in the United States has greatly benefitted from the regulatory regime that developed on the basis of the pattern of "cooperative federalism."[170] The entire process is governed by complex state and federal agencies that deal, respectively, with drilling operations and the monitoring of water treatment and disposal activities. Despite this division of competences, in practice the federal government has delegated a considerable portion of its powers to the states that provide for identical or better standards than the minimum ones set at the federal level. As a consequence, at the state level, shale gas regulation varies widely, depending on the specific interest and on political assessments in relation to the extraction of this resource.[171] Due to this wide regulatory fragmentation, federal

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What Is Shale Gas and Why Is It Important?, ZERORPM (Dec. 5, 2012), http://www.zerorpm.com/about/zerorpm-difference/blog/entry/what-is-shale-gas-and-why-is-it-important. In 2000, shale gas represented only 1 percent of the U.S. natural gas demand. David Brooks, *Shale Gas Revolution*, N.Y. TIMES, Nov. 4, 2011, at A31. In 2012, its percentage has increased to 30 percent. *See* U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2013 WITH PROJECTIONS TO 2040, at 9–10, DOE/EIA-0383 (2013). The most important incentive to increasing natural gas demand in the United States has been the electrical production achieved by replacing coal-powered plants or by increasing existent production capacity. At the same time, exports have the potential to facilitate demand development and make the natural gas sector more competitive. Finally, an increase in gas demand could be engendered by a series of factors, such as the use of natural gas vehicles, electricity production, and gas demand for industrial purposes. Kenneth W. Costello, *Exploiting the Abundance of U.S. Shale Gas*: *Overcoming Obstacles to Fuel Switching and Expanding the Gas Distribution System*, 34 ENERGY L.J. 542, 543–44 (2013).

170. Francis Gradijan, *State Regulations, Litigation, and Hydraulic Fracturing,* 7 ENVTL. & ENERGY L. & POL'Y J. 47 (2012).

171. For example, New York requires a comprehensive environmental impact assessment, an application to gain the permission to start drilling, and a preventive procedure plan. In Texas, drilling permission is granted easily, provided that every project presented is accompanied by an environmental impact assessment. On the different state regulations in the United States, see in general David H. Getches, *Groundwater Quality Protection: Setting a National Goal for State and Federal Programs*, 65 CHI.-KENT L. REV. 387, 410 (1989); Mark A. Latham, *The BP Deepwater Horizon: A Cautionary Tale for Ccs, Hydrofracking, Geoengineering and Other Emerging Technologies with Environmental and Human Health Risks,* 36 WM. & MARY ENVTL. L. & POL'Y 31, 56 (2011); Hannah Wiseman, *Fracturing Regulation Applied*, 22 DUKE ENVTL. L. & POL'Y F. 361 (2012). Such differentiation among state legislations becomes evident through analysis of regulation of the "Marcellus" shale gas

minimum standards have often been ignored or applied with a wide margin of discretion according to the political line of the concerned state.[172] Standardization over this differentiated ap-

field, where every state involved executes different regulatory frameworks, while complying with federal principles, which only set minimum requirements for fracking activities. More specifically, noxious waste and toxic chemical transportation are governed by federal transport acts. The Clean Water Act prohibits the release of pollutants in a watercourse without specific authorization. Clean Water Act, 33 U.S.C. § 1251 et seq. (1971). Federal law lays down various forms of liability for the pollution of sites intended to be used for well drilling, in compliance with the Safe Drinking Water Act (SDWA), aiming at "protecting public health and regulating the supply of drinkable water at the national level." Safe Drinking Water Act, Pub. L. 93-523, 88 Stat. 1660 (1974). Similarly, the EPA has the task to issue regulations regarding fluid introduction in the subsoil, so as to protect potable subterranean aquifers. Until 1997, the EPA interpreted the definition of "subterranean introduction" contained in Section 300 of the SDWA as not applying to the subterranean storage of fluids, and excluding oil and natural gas extraction techniques, including fracking. 42 U.S.C. § 300h(d); Cupas, *supra* note 55, at 605–06. This interpretation was overruled in *Legal Environmental Assistance Foundation v. U.S. EPA*, 118 F.3d 1467 (11th Cir. 1997), where the Eleventh Circuit Court of Appeals stated that the SDWA interpretation followed by the EPA was wrong, and that fracking had to be considered included in the definition of "subterranean introduction," and therefore subject to regulation. Despite this decision, in 2005, Congress amended Section 300(d) of the SDWA in order to specifically exclude fracking. For an overview of the connection between the Safe Drinking Water Act and fracking, see Keith B. Hall, *Regulation of Hydraulic Fracturing Under the Safe Drinking Water Act*, 19 BUFF. ENVTL. L.J. 1 (2012); Holly A. Vandrovee, *The Fight Over Fracking: Recent Hydraulic Fracturing Litigation in Texas*, 74 TEX. B.J. 390, 391 (2011).

172. This differentiated approach is clear in the recovery and disposal of fracturing fluid. For example, New York chose to endorse the precautionary principle, while Ohio and West Virginia adopted a non-intervention policy, and are promoting shale gas development and exploitation through a minimal regulation. *See generally, e.g.*, Hannah Wiseman, (presented 2012, March). State and Local Regulation of Shale Oil and Gas Development: Adaptation, Experimentation, or Chaos? Presentation at Conference on Federalism and Energy in the United States, Searle Center, Northwestern University Law School, Chicago, IL. (National). Here, it is useful to refer to the fundamental aspects of the precautionary principle. This principle has been developed first in the environmental policy area. Already the Ministerial Declaration of the Second International Conference on the Protection of the North Sea (1987) states: "in order to protect the North Sea from possibly damaging effects of the most dangerous substances, a precautionary approach is necessary which may require action to control inputs of such substances even before a causal link has been established by absolutely clear scientific evidence." Second International Conference on the Protection of the North Sea,

proach from state to state is desirable, especially for the regulation of environmental matters.[173]

Ministerial Declaration (1987), http://www.vliz.be/imisdocs/publications/140155.pdf. Later, during the Third International Conference on the Protection of the North Sea (1990), a new Ministerial Declaration clarified the previous one: "Participating governments will continue to apply the precautionary principle, that is to take action to avoid potentially damaging impacts of substances that are persistent, toxic and liable to bioaccumulate even where there is no scientific evidence to prove a causal link between emissions and effects." Third International Conference on the Protection of the North Sea, Ministerial Declaration (1990), www.vliz.be/imisdocs/publications/140228.pdf. Finally, the principle has been specifically legitimized in Principle 15 of the Rio Declaration: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." U.N. Conference on Environment and Development, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26 (Vol. I) (Aug. 12, 1992). The principle was later recalled in similar terms in the Preamble of the Convention on Biodiversity (1992), in Article 3 (Principles) of the Convention on Climate Change (1992), and in the Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (September 1992). The principles that should inspire recourse to the precautionary principle are the following: (i) implementation of the principle should be founded on the most complete scientific assessment possible, which determines at every moment the degree of scientific uncertainty; (ii) any decision on whether to act under the precautionary principle should be preceded by an assessment of the risk and of the potential consequences of not acting; and (iii) as soon as the results of the scientific assessments and/or of the risk assessment are available, all the stakeholders should have the chance to participate in the evaluation of the various foreseeable actions with the greatest possible transparency. *See* Giovanni Cordini, Paolo Cordini, Paolo Fois, Sergio Marchisio, Diritto Ambientale. Profili internazionali europei e comparati (2d ed. Giappichelli, 2008); Mariachiara Alberton, La quantificazione e la riparazione del danno ambientale nel diritto internazionale e dell'Unione Europea (Giuffrè, 2008).

173. Schauwecker reaffirms that the EPA has the duty, pursuant to the Water Use Efficiency and Conservation Research Act of 2009 (H.R. 631 (111th)), to manage the risks linked to fracking, as this legislation "imposes on the US Environmental Protection Agency the drafting of a research and development programme that fosters water efficiency and conservation." Schauwecker, *supra* note 111, at 47. Deweese affirms that by far state regulation has proved to be ready and effective, and that the Congress' efforts to connect fracking to the SDWA will only hold back further industrial development of this fundamental resource. *See generally* Dewesee, *supra* note 118. *See also* Cameron Jefferies, *Unconventional Bridges Over Troubled Water: Lessons to Be Learned from the Canadian Oil Sands as the United States*

A. Pricing and Fiscal Regime

In 1978, the United States implemented the Natural Gas Policy Act (NGPA),[174] which entailed gradual removal of price controls and supplied economic subsidies for the development of new natural gas sources, including for gas obtained from unconventional sources. Previously, the maximum price for interstate natural gas was set at a level that was artificially lower than the equilibrium price that would have arisen from free competition in the marketplace.[175] This rate regulation produced an increase in demand and a tightening in supply, with consequent repercussions on natural gas stocks and on production.[176] Moreover, the NGPA contained advantageous condi-

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Moves to Develop the Natural Gas of the Marcellus Shale Play, 33 ENERGY L.J. 75 (2012).

174. Natural Gas Policy Act, 15 U.S.C. § 3301 (2015). On this matter, see generally Richard Greer Morgan & Martha Priddy Patterson, *Natural Gas Policy Act of 1978: Four Years of Practice and Two Years to Make Perfect, The,* 71 KY. L.J. 105 (1982); Joseph P. Tomain, *The Dominant Model of United States Energy Policy,* 61 U. COLO. L. REV. 355 (1990); Rodney L. Brown, Jr., *Legislative History of the Natural Gas Policy Act: Title I,* 59 TEX. L. REV. 101 (1980).

175. *See generally* Kevin L. Ward, *Preemption Survives Deregulation of Natural Gas: Transcontinental Gas Pipe Line Corp. v. State Oil and Gas Board of Mississippi*, 22 TULSA L. J. 639 (1986).

176. After the oil embargo in 1973 and the following "energy crisis" in 1979, the U.S. government fostered a large number of projects, including the strengthening and expansion of research and development projects linked to energy sources, which were later salvaged with the creation of the DOE, and to which has been given the task of identifying and best defining the respective responsibilities and competences of all federal energy plans and research and development plans. It should be noted that the first oil crisis, coinciding with the embargo put into effect by the Arab countries in 1973, resulted from the hostilities that arose between Arab countries and Israel during the Yom Kippur War, the fourth and last of the Israeli-Arab conflicts. In fact, for the first time in history, an oil-exporting country decided to use oil as a real weapon of war. Oil prices increased by 70 percent, reaching $5.11 per barrel. In addition to the price increase, an embargo was announced, and production fell by 5 percent in the first month, continuing with equal reductions during each month following. The embargo against the United States was total, as a reaction to the support it gave to Israel. The second oil crisis resulting from the Iranian revolution, took place between 1978 and 1979. Iran stopped its production, and the consequent oil shortage, which at first was balanced by a production increase by other Organization of the Petroleum Exporting Countries (OPEC) members, started to be widely felt, as Iran was globally the second largest oil-producing country. *Petroleum History of Events 1970-2000*, U.S. ENERGY INFO. ADMIN. (May 2002),

tions for unconventional gas also in light of the very high extraction costs involved.[177] This partial natural gas price deregulation constituted a critical advantage for the development of these natural resources.

Turning to natural gas tariff regulation in China, the lack of a national agency responsible for pricing creates uncertainties in potential investors. The Chinese pricing regime for natural gas is a mosaic of different market and administered prices, set according to a number of factors.[178] The Twelfth Five-Year Plan (2011–2015) foresees a doubling of the output of gas-fired power plants and an increase in the consumption of natural gas by households.[179] This is the reason the price of natural gas is kept at an artificially depressed level that is lower than the international market price. The consequent gap with domestic prices forces Chinese firms to import gas at a loss, significantly reducing the potential relevance of natural gas. The current government intervention and monopoly energy prices neither reflect the scarcity of resources nor demand in the market. Furthermore, price distortions are not conducive to the effectiveness of market mechanisms and the allocation of resources, since energy prices are detached from the market, which forces the government to subsidize certain energy industries, worsening the financial burden.[180] Today, China's gas pricing is a cost-plus regime that is disciplined throughout the entire value chain.[181] It has undergone some changes as the economy moves towards a market-

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http://www.eia.gov/pub/oil_gas/petroleum/analysis_publications/chronology/petroleumchronology2000.htm.

177. 15 U.S.C. § 3301 (1978).

178. For a comparative analysis of the U.S. gas-pricing regime, see Boriss Siliverstovs et al., *International Market Integration for Natural Gas? A Cointegration Analysis of Prices in Europe, North America and Japan,* 27 ENERGY ECON. 603 (2005).

179. National People Congress of China, Twelfth Five-Year Plan (2011-2015), (March 2011), http://www.britishchamber.cn/content/chinas-twelfth-five-year-plan-2011-2015-full-english-version.

180. *Id*. Zhu Yi, *Zhongguo Nengyuan Shichang Xianzhuang Fenxi: Jianlun Zhongguo Nengyuan Shichang Guojihua* [*Chinese Situation of Energy Market: Discussion on the Internationalization of China's Energy Market*], 8 ZHEJIANG JINGJI [ZHEJIANG ECON.] 17 (2004).

181. Cost-plus pricing entails that, in accordance with the value chain, the pricing formation flows from the price set by the government for the upstream producer to the midstream pipeline operator and then to the end user. YI CHEN, DEVELOPMENT STRATEGIES OF THE CHINESE NATURAL GAS MARKET 19 (2013).

based economy. In spite of this, it essentially follows a fixed-price model, and a market-based pricing mechanism has yet to be developed.

As a result, price and regulatory reform are much needed. Experimental price mechanisms have already been implemented, starting in December 2011, in the province of Guangdong and in the Guangxi region, where gas prices are no longer kept artificially lower than the market price levels, but are instead connected to the market price of fuel oil and liquefied petroleum gas imported to Shanghai, which is a Chinese hub for gas trading and consumption.[182] This trial reform overhauls the old pricing formation and moves toward an oil-indexation mechanism. The final objective is to liberalize the wellhead price and establish a market-based pricing regime. It will rely on the concept of oil indexation to determine the gas price. By connecting the price of domestic natural gas with the international price of its competing fuel, the oil-indexed price formula will mirror international market fundamentals and demand. Eventually the wellhead price will no longer be subject to government-administered price, but will be set on a market basis.[183] The cost-plus regime does not provide the fundamental price signal that a market economy requires. A clear price signal is essential to reflect the market value of natural resources, to indicate the market trend, and to guide investment decisions. The low domestic price creates disincentives to upstream companies from investing in Exploration and Production, thus hindering the development of conventional and unconventional reserves.[184] Furthermore, the current Chinese shale gas explo-

182. OXFORD INST. FOR ENERGY STUD., THE DEVELOPMENT OF CHINESE GAS PRICING: DRIVERS, CHALLENGES, AND IMPLICATIONS FOR DEMAND 9 (Registered Charity No. 286084, 2014) http://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/07/NG-89.pdf.

183. *Id*. at 22–24.

184. *Id*. at 22. Preferential pricing has already been adopted in other unconventional gas resources that present higher extraction costs as compared to conventional resources. These regimes could reasonably be extended to shale gas production. The government has implemented several preferential policies to support coalbed methane and coalmine methane extraction and commercialization. CHINA GREENTECH INITIATIVE, UNCONVENTIONAL GAS IN CHINA 8 (2011), http://www.chinagoabroad.com/sites/v2/files/v1_attachments/2012/04/CGTI2011-CCE-WS1-Unconventional-Gas.pdf. Other policies include exemption from corporate tax for the first two years of production and a reduction of 50 per-

ration and exploitation framework should also be improved in relation to the tax system, which is a critical element in investment development and in the fostering of efficient resource use.

The current Chinese shale gas regulatory framework should be enhanced in two particular sectors, namely the fiscal and pricing regimes, which are key elements in fostering needed investments and promoting efficient use of resources. Under China's production-sharing contracts, international energy companies must share a percentage of their profits with the government or government-owned companies, in addition to paying corporate taxes on gains.[185] This creates a deterrent for overseas investors to invest in high-risk activity such as shale gas exploration and production. Conversely, the U.S. regulatory regime, based on royalties, requires energy firms to pay merely a portion of project revenues and corporate taxes on gains.

Other factors were also important in U.S. shale gas development. First, in the 2000s, natural gas prices were particularly high.[186] This allowed companies to realize significant profit margins from drilling shale gas wells. The prospect of high profit margins pushed existing energy enterprises and new entrants to invest heavily in shale gas fields, which eventually pushed down natural gas prices.[187]

B. Barriers to Entry and Consequences on Competition in the Gas Market

The barriers to entry for small and large firms into the American shale gas industry were much lower than in China as individual companies were able to lease or acquire land to explore. They were only required to submit paperwork to the state government.

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cent for the following three years, exemption from mining-rights fees, royalty fees, value-added tax (VAT), and feed-in-tariffs for coalbed methane and coalmine methane-fired power. *Id.*

185. *See generally* Erica Downs, *Who's Afraid of China's National Oil Companies?*, *in* ENERGY SECURITY: ECONOMICS, POLITICS, STRATEGIES AND IMPLICATIONS (2010).

186. Zhongmin Wang & Alan Krupnick, *US Shale Gas Development What Led to the Boom?*, RESOURCES FOR THE FUTURE, May 2013, at 10, http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-IB-13-04.pdf

187. *Id.*

The North American market structure also played a decisive role in development of the shale gas industry, which is undoubtedly one of the most capital-intensive industries. It follows that small natural gas firms do not have the financial capacity and technical know-how to make substantial venture investments in technology. Indeed, in the United States it was large, independent natural gas firms that significantly invested in the early stage of shale gas development. Conversely, the major oil firms, although having the capacity, considered shale gas less appealing as an investment than conventional oil and gas. The capital market's role was fundamental in this context, and contributed to pushing the shale gas boom forward by providing natural gas firms with copious capital to drill, and it also eased many transactions in which larger oil and gas enterprises bought out smaller firms committed to shale gas drilling.[188]

In China, however, the central government exerts power firmly on shale gas blocks by organizing auctions or granting exploration rights.[189] This scheme creates various barriers to entry for both small and large overseas firms into the domestic shale gas industry,[190] because in order to take part in auctions, firms had to be either Chinese or Chinese-held joint-venture companies, and they needed to have an extremely elevated minimum value.[191] In particular, the approval system for for-

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188. *Id*. at 11.

189. *Id*. at 10.

190. In the first auction, held in June 2011, only state-owned companies were admitted to compete. This auction stimulated a feeble response, as only six companies put in bids for four blocks, and only two blocks were eventually awarded. A second auction was organized in October 2012, collecting 152 bids for twenty blocks. CSIS, *China Awards More Shale Gas Blocks Although Much Remains to be Seen* (Jan. 23, 2013), http://csis.org/publication/china-awards-more-shale-gas-blocks-although-much-remains-be-seen.

191. Enterprises are required to invest at least RMB 30,000 ($4747 USD) per square meter annually, three times the minimum amount for crude oil exploration. Additionally, the second shale gas tender, launched in 2012, required bidding companies to have 300 million yuan ($47.4 million USD) in registered capital. Ministry of Land & Res. of the People's Republic of China, *Shale Gas Tender Submission Announcement*, RFFF.ORG (May 17, 2012), http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-IB-13-04.pdf (in Chinese). While a high market entry threshold may defeat China's goal of attracting diversified investment and fostering competition, this practice may lessen environmental risks, as in China small and medium-sized companies

eign investments in the mineral industry, embracing any underground activities, is subject to both foreign capital and industry access approval mechanisms.[192] The former implies a multitiered administrative approval system according to which authorities of different levels exercise different powers over different industrial categories and total investment amounts. As for industry access, China enforces an authorization scheme for the exploration and exploitation of underground natural resources. Specifically, the investor must apply for registration, hold an exploitation or exploration license, and gain the right of exploration and exploitation.[193]

As one might expect, such a burdensome policy for foreign investments in the Chinese mineral industry is far from conducive to shale gas production. Joint ventures between domestic and foreign companies through both inbound and outbound investments for extraction technology and potentially for infrastructure development seem to be the best strategy in this early stage of the shale gas industry. Obviously, Chinese restrictions on foreign investments constitute a relevant barrier. As explained above, prior to January 30, 2012, exploration and exploitation of shale gas in China could only be carried out by Chinese state-owned companies. However, according to the revised Foreign Investment Industry Guidance Catalog, shale gas foreign investments are included in the "encouraged" category of the catalog, allowing foreign investors to form with their Chinese partners Sino-foreign joint ventures and Sino-foreign contractual (cooperative) joint ventures.[194] Additionally, an MLR Circular issued on October 26, 2012, reaffirms that private Chinese oil companies may also explore for and exploit shale gas, including by way of creating joint ventures with foreign companies. The regulations do not specify a maximum

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are more difficult to regulate and have less financial and technical ability to adopt best practices. *See* Enoe et al*., supra* note 22.

192. CHINESE ACAD. OF LAND & RES. ECON., DEP'T OF SCI. & TECH. & INT'L COOPERATION OF THE MINISTRY OF LAND & RES., A GUIDE TO INVESTMENT IN CHINA'S MINERAL INDUSTRY 13 (2012), http://www.chinaminingtj.org/en/document/A_Guide_to_Investment_in_China's_Mineral_Industry(2012).pdf.

193. *See generally id.*

194. *See Catalogue of Encouraged Foreign Investment Industries*, MINISTRY COMM. PEOPLE'S REPUBLIC CHINA II(6), II(9) (Feb. 21, 2012), *translation at* http://english.mofcom.gov.cn/article/policyrelease/aaa/201203/20120308027837.shtml.

percentage equity shareholding that a foreign company is permitted to hold in such a joint venture; however the MLR's public bidding invitation terms require that the Chinese party must have a majority ownership.[195] Furthermore, investors will likely wait to see what shale gas-pricing policies and government support mechanisms are put in place before actually investing in Chinese shale gas, as uncertainty and regulatory changes might have detrimental effects on them.[196]

In this context, it should be pointed out that the absence of competition in the energy market generates an unfair allocation of resources. In fact, in 2001, China joined the World Trade Organization (WTO), and consequently must increase competitiveness of state-owned energy companies while restraining national control over energy companies.[197] At the moment, there is no actual competition between the three major Chinese oil companies, as they have the same, single shareholder, i.e., the State-owned Assets Supervision and Administration Commission of the State Council ("SASAC"). Indeed, there is no competition in either the upstream or downstream energy sectors, as they feature market monopolies and administrative price guides,[198] regardless of the fact that both the Twelfth Five-Year Plan (2011–2015) and the 2012 Energy

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195. Dina Yin, Zhao Yan, *Shale Gas and CBM Companies to Pay VAT*, CHINA L. INSIGHT (June 28, 2013), http://www.chinalawinsight.com/2013/06/articles/fdi/shale-gas-and-cbm-companies-to-pay-vat/.

196. *See* KPMG GLOB. ENERGY INST., *supra* note 51, at 11.

197. As a condition for joining the WTO, China agreed to reduce tariffs on all imported goods and open its markets to foreign investors. In return, China has benefitted from the Most Favored Nation treatment and reciprocal rights for trade and investment. *See* Farah, *supra* note 82. In addition, China agreed on the establishment and enforcement of a stronger intellectual property rights regime. Paolo Farah & Elena Cima, *China's Participation in the World Trade Organization: Trade in Goods, Services, Intellectual Property Rights and Transparency Issues*, *in* EL COMERCIO CON CHINA. OPORTUNIDADES EMPRESARIALES, INCERTIDUMBRES JURÍDICAS 83, 100–01 (Aurelio Lopez-Tarruella Martinez ed., 2010).

198. In practice, CNPC, the Sinopec Group, and CNOOC possess the absolute majority of the exploration blocks, despite the fact that the 1998 Mineral Resources Exploration Block Regulation stipulates that 25,000 unit blocks are the maximum features in exploration projects of oil and gas. *See generally*, Chen Shou Hai, *Woguo Tianranqi Chanye de Longduan Ji Falv Guizhi* [*Legal Regulation of Monopoly in China's Natural Gas Industry*] in NENGYUAN YANJIU BAOGAO [ENERGY L. RES. REP.] 336 (2012).

White Paper call for the introduction of private-capital and market mechanisms, which would terminate the current energy monopoly that exacerbates lack of supervision and inefficiency.[199] The only way China could improve its future energy policy is by converting nonmarket mechanisms to market mechanisms, adopting a modern corporate system for energy companies, and changing the government management system from strict controls to limited supervision.[200]

Another aspect that has certainly advanced the growth in shale gas development in the United States is its distinctive market structure for gas transportation. In particular, "ownership of transportation capacity rights is unbundled from ownership of the pipeline itself."[201] This makes it possible for many of the small producers that first ventured into shale to access the market through a competitive bid for pipeline capacity. This is an inherent problem affecting market access in China, where pipeline capacity is bundled to facility ownership, and large incumbent state-owned enterprises dominate the entire transportation infrastructure.

C. Mineral Rights Ownership Regulation

Another fundamental element of the present comparative analysis is the land and mineral rights ownership regime. In the United States, shale gas development has taken place mainly on private land.[202] Private land ownership allowed natural gas firms a way to ensure reasonable returns from their early investments in technology innovations through acquiring land, proving its potential, and then selling it. Private mineral

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199. The National Energy 12th Five-Year Plan calls for a reform of energy mix, advocates for a rationalization of energy-pricing mechanisms to encourage private capital to invest in the field of energy, fosters the granting of propriety to encourage technological progress, and to progress in the innovation of scientific and technical equipment. In the same vein, the 2012 Energy White Paper promotes a sustainable use of energy through the establishment of a market mechanism in energy pricing, and the creation of interconnected institutional mechanisms. Text in English of the Energy and Climate Goals of China's 12th Five-Year Plan http://www.c2es.org/docUploads/energy-climate-goals-china-twelfth-five-year-plan.pdf

200. NI JIAN MING, GUOJIA NENGYUAN ANQUAN BAOGAO [NATIONAL ENERGY SECURITY REPORT] 329–30 (2005).

201. KENNETH B. MEDLOCK ET AL., SHALE GAS AND U.S. NATIONAL SECURITY 14 (2011).

202. Wang & Krupnick, *supra* note 186.

rights ownership creates a constituency favoring drilling and helps restrain the temptation of governments to raise revenues through shale gas drilling.[203] China has auctioned off drilling blocks, and has required a certain minimum investment to develop auctioned blocks within a certain period of time.[204] In theory, this should force firms to drill but it is not clear whether this mechanism would offer a sufficient incentive to innovate. On the other hand, private land ownership carries the risk that some speculating energy companies may rent large areas of land without making appropriate investments. In China, below-ground mineral rights are owned by the state. State ownership can back operators piecing together contiguous blocks of land, achieving a more efficient and unhindered exploitation of a gas field. Moreover, the government can lease the drilling rights at below-market rates if it wishes to.

A further element to be analyzed is the legal regime concerning water-rights regulation in the United States.[205] A mineral lease to a shale gas operator generally comprises the details of what consumption the operator can make of water on the surface of the property, and the specific lease terms will govern the relationship between the surface fee owner and mineral rights holder.[206] Customarily, these contracts allow water to be employed for operating on the premises and the owner or operator can use a reasonable quantity of water so long as other ri-

203. *Id.* at 10.

204. U.S. Energy Info. Admin., *China: International Energy Data and Analysis*, at 20 (May 14, 2015), https://www.eia.gov/beta/international/analysis_includes/countries_long/China/china.pdf.

205. The water rights regulation in the United States is derived from the English "riparian" rights regime. Accordingly, landowners adjacent to waterways gain water rights to that waterway as an appurtenant feature of land ownership. The specific rights that landowners gain depend on the type of water in question. The rights are designed to address the following water resources: (i) "diffused surface water" (such as rainwater); (ii) traditional stream, river and lake surface water; (iii) groundwater that flows in "well-defined subterranean streams"; and (iv) "percolating groundwater." For an overview on this point, see R. Timothy Weston, *Harmonizing Management of Ground and Surface Water Use Under Eastern Water Law Regimes*, 11 U. DENV. WATER L. REV. 239 (2007-2008).

206. Cameron Jefferies, *Unconventional Bridges Over Troubled Water - Lessons to be Learned from the Canadian Oil Sands as the United States Moves to Develop the Natural Gas of the Marcellus Shale Play*, 33 ENERGY L.J. 75, 100 (2012).

parian rights holders are not prejudiced in their use.[207] In fact, the reasonable use doctrine renders "virtually all uses of water made upon the land from which it is extracted . . . 'reasonable,' even if they more or less deplete the supply to the harm of neighbors, unless the purpose is malicious or the water is simply wasted."[208] Some states comprising the Marcellus Shale, namely New York and Ohio, have implemented a "regulated riparian" pattern to deal with these unclear provisions.[209] Conversely, Pennsylvania and West Virginia depend heavily on common law regulatory precedents, and have yet to pass permitting procedures.[210]

D. Pipeline Network

Moreover, in the United States, an extensive and sophisticated network of natural gas pipelines existed before shale gas became a major gas resource. Fundamental in this context was the policy of open access to interstate natural gas pipelines (as well as storage facilities) resulting from a series of Federal Energy Regulatory Commission (FERC) orders in the 1980s and early 1990s.[211] In the following years, significant technological advances enabled a surge in investment in the production of shale gas, which determined a surge in supply coupled with strong demand driven by sustainable low natural gas prices.[212] This constituted an exciting opportunity for energy infrastructure providers. Today, infrastructure investors benefit from attractive opportunities, relatively stable low-risk cash flows underpinned by long-term contracts, and growth perspectives stemming from the need for expanded pipeline capacity. This scenario has increased the potential for attractive returns and represents a crucial case for investment in energy infrastruc-

207. *Id.* at 100.

208. *Id.* at 250.

209. *Id.* at 255.

210. *Id.* at 250–59.

211. *See in particular*, FERC 1985 Order No. 436, the Natural Gas Wellhead Decontrol Act (NGWDA) passed by Congress in 1989, and FERC 1992 Order No. 636. *See also* Richard J. Pierce, *Reconsidering the Roles of Regulation and Competition in the Natural Gas Industry,* 97 HARV. L. REV. 345 (1983).

212. *See generally* Dan Alger & Michael Toman, *Market-Based Regulation of Natural Gas Pipelines,* 2.3 J. REG. ECON. 263 (1990); Harry G. Broadman & Joseph P. Kalt, *How Natural Is Monopoly? The Case of Bypass in Natural Gas Distribution Markets,* 6 YALE J. REG. 181, 184 (1989).

ture across the gas supply chain. In the United States, investors rely on provisions of pipeline infrastructure that are generally predicated on stable, fee-based revenues, largely insulated from direct commodity price exposure. Additionally, more than half of the top midstream pipeline enterprises have adopted a "master-limited partnership" structure as an effective alternative to a corporate structure.[213] This partnership model does not pay corporate tax, which has contributed to promoting investment in the shale gas industry.[214]

Although China has a considerable reserve estimate, the development of shale gas as a key element of the country's energy mix may be undermined by the lack of adequate physical infrastructure, mainly gas pipelines for transport and delivery. Large-scale pipelines will have to be built to manage the capacity of targeted output and to transport the product from the major gas fields, which could be challenging for smaller exploration and production firms.[215] In particular, there is no integrated national gas grid, and most of China's infrastructures were constructed to transport its most important fuel, coal.[216] Currently all principal gas transmission lines are owned by the state,[217] and a number of new pipelines are needed. Developing transportation and storage facilities is crucial for shale gas expansion, and even though much still needs to be done, China

213. Maquarie Inv. Mgmt., *US Shale Gas: A Good News Pipeline* 2 (2012), https://www.macquarie.com.au/dafiles/Internet/mgl/au/mfg/mim/docs/mim-insight/mim-insight-apr12-shalegas.pdf?v=1; *Conoco Eyeing Chinese Shale Despite Block Exits*, ENERGY CHINA FORUM (May 28, 2015), http://www.shalegaschinasummit.com/News_Show.asp?pid=9156.

214. *Id*.

215. *See* KPMG GLOB. ENERGY INST., *supra* note 51, at 10.

216. 45 percent of domestic railway capacity is devoted to coal transport. On the coal sector in China, see Mou Dunguo & Zhi Li, *A Spatial Analysis of China's Coal Flow,* 48 ENERGY POL'Y 358 (2012); Richard Heinberg & David Fridley, *The End of Cheap Coal,* 468 NATURE 367–69 (2010); Wang Bing, *An Imbalanced Development of Coal and Electricity Industries in China*, 35 ENERGY POL'Y 4959 (2007); Lin Bo-qiang & Jiang-hua Liu, *Estimating Coal Production Peak and Trends of Coal Imports in China,* 38 ENERGY POL'Y 512 (2010).

217. Currently, CNPC essentially monopolizes pipeline construction and operations in China. It owns and operates 90 percent of pipelines. Whether CNPC would allow for shale gas transport by the third-party through their pipelines still need to be seen, since it has no legal obligation to do so. *See* Guo-Hua Shi et al., *Development Status of Liquefied Natural Gas Industry in China*, 38 ENERGY POL'Y 7457 (2010).

plans to build 14,400 miles of new gas pipelines between 2010 and 2016 to reinforce the current 21,000-mile network.[218] In addition, China will need to construct or reinforce infrastructures that can safely dispose of the contaminated material used to fracture the shale rock, and thus protect the environment. Energy expert Diana Ngo stresses that these factors are important because they will reduce costs caused by environmental damage occurring in the future.[219] Additionally, these precautionary steps will also help China exponentially speed up its well-development timeline (for instance, PetroChina took a lengthy period of eleven months to complete the country's first horizontal well).[220]

E. The Politics of Shale: Grounds for International Cooperation

Shale gas development has deeply modified the energy scenario in the United States from a status of shortage to that of plenty. Already the world's biggest energy consumer, the United States may soon become the largest producer of hydrocarbons.[221] As a consequence of the shale gas revolution, North

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218. On January 23, 2013, the State Council issued the notice of the Energy 12th Five-Year Plan stressing that, due to the instability of marine energy transportation, China will develop on-shore pipeline constructions for oil and gas transportation, which should reduce energy supply security threats. Enhancing transportation and storage facilities would help to expand shale gas development. Furthermore, some parts of the shale gas rich provinces have existing pipeline networks, but small-scale LNG and compressed natural gas technologies may be necessary to boost the early stage of shale gas development in China. At the moment, the 4200-km West-East Pipeline links the Tarim and Ordos Basins to markets in the Shanghai area. The second West-East Pipeline was completed in June 2011, although several sub-lines remain to be completed. A recently completed 1700-km gas pipeline carries Sichuan Province gas to Hubei, Anhui, Jiangxi, Jiangsu and Zhejiang Provinces, and Shanghai. JANE NAKANO, DAVID PUMPHREY, ROBERT PRICE, JR. & MOLLY A. WATSON, PROSPECTS FOR SHALE GAS DEVELOPMENT IN ASIA EXAMINING POTENTIALS AND CHALLENGES IN CHINA AND INDIA 7, 19 (2012), http://csis.org/files/publication/120911_Nakano_ProspectsShaleGas_Web.pdf.

219. Diana Ngo, *3 Reasons Why Shale Gas is a Pipe Dream in China- Part I*, ENERGY IN ASIA (May 11, 2012), http://energyinasiablog.com/2012/05/; Diana Ngo, *Why China Lags Behind the U.S. in Shale Gas Development,* ENERGY IN ASIA (Jan. 15, 2013), http://energyinasiablog.com/2013/01/15/why-china-lags-behind-us-shale-gas-development/.

220. *Id.*

221. Much of the credit for the technological advancements that made shale gas development possible are owed to the members of the Mitchell Energy shale gas team, in particular to the late George Mitchell (1919–2013), who

America's natural gas base, now estimated at 3400 trillion cubic feet, could provide for current levels of consumption for over one-hundred years.[222] Shale gas, replacing oil as the principal agent of a new global energy equilibrium, is already transforming global energy relations, and the impact will be more evident when gas exports begin (the first LNG exports are expected to start around 2017).[223] There are several LNG terminals located in the United States, originally constructed to import gas, which are now looking to start exporting possibly to Europe, India, and China, as a way to extend their sphere of influence while reducing the dominance of the Middle East and Russia in the gas sector. The shale gas revolution has modified the economics of oil and gas production in the United States, reducing dependence on imported oil and gas supplies and reinforcing domestic manufacturing through lower energy costs.

Over the last decade, the political attitude towards shale gas has been changing, and more consideration is given to concerns regarding shale's potential detrimental effects on the environment, and in particular water sources. Accordingly, the Obama administration plans to enforce more stringent controls over drillers by forcing them to seize emissions of determined air pollutants from new wells beginning in 2015.[224] The rapid de-

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worked to refine shale technologies despite harsh criticism, especially in the Barnett shale formation of northern Texas. Hydraulic fracturing 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; *see also The Good News About Gas- The Natural Gas Revolution and its Consequences*, *supra* note 166; *The US Natural-Gas Boom Will Transform the World*, *supra* note 166.

222. *See* Yergin, *supra* note 26, at 332.

223. Keith Johnson & Ben Lefebvre, *U.S. Approves Expanded Gas Exports*, WALL ST. J. (May 18, 2013, 11:18 AM), http://www.wsj.com/articles/SB10001424127887324767004578489130300876450.

224. In President Barack Obama's March 30, 2011, energy proposal, he indicated that shale gas could play a large role in U.S. energy policy, particularly with mitigation of its environmental impacts:

> Recent technology and operational improvements in extracting natural gas resources, particularly shale gas, have increased gas drilling activities nationally and led to significantly higher natural gas production estimates for decades to come. The Administration is taking steps to address these [environmental] concerns and ensure that natural gas production proceeds in a safe and responsible manner.

velopment of shale gas in the United States has nevertheless stoked environmental controversy and debate. The suitability of taking the U.S. regulatory framework as a model scheme remains debatable because the United States is experiencing difficulties with environmental aspects related to shale gas extraction,[225] in particular given the complex barriers that developing countries such as China are facing in this sector. Nevertheless, it is likely that a comparative analysis might contribute to resolving some of these issues.

Large-scale production of shale gas in the United States is already transforming worldwide dynamics of the gas industry. The rapid growth of this new resource created a global surplus of LNG, whose rapid buildup coincided with the emergence of shale gas as a new supply source.[226] Until 2010, the United States was supposed to be the greatest LNG market due to a projected domestic shortfall. Conversely, shale gas increase may transform the United States into an LNG exporter, leaving much LNG in search of a market that will be only partially absorbed by growing Asia. This over-supply of LNG fostered wider competition among gas suppliers and reduced prices. It is also modifying the economic and political equilibrium stemming from a new, wider geopolitical impact of the global gas market, which is engendering new gas competition.[227] As shale gas expands globally, we should assess the possible consequences of price development in relation to the potential establishment of an Organization of Gas Exporting Countries (OGEC), stemming from the Gas Exporting Countries Forum (GECF), a gas-exporting countries forum with headquarters in Doha, Qatar (which is the main gas supplier to Europe, after

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White House Office of the Press Secretary, *Remarks by the President on America's Energy Security*, WHITE HOUSE (Mar. 30, 2011, 11:36 AM), https://www.whitehouse.gov/the-press-office/2011/03/30/remarks-president-americas-energy-security. *See generally* Jody Freeman, *Climate and Energy Policy in the Obama Administration*, 30 PACE ENVTL. L. REV. 375 (2012).

225. *See* Reeder, *supra* note 130 (describing the complex legal obstacles inherent to shale gas development).

226. In the United States, the surplus of domestic gas production is partly due to the mismatches between LNG project start-ups and the completion of LNG tanker construction combined with the expiry of charter agreements for older tankers as a result of production declines in older projects. *See* STEVENS, *supra* note 17, at 21.

227. *See* Yergin, *supra* note 26, at 335.

Russia).[228] In particular, if gas prices further lower reducing exporters' revenues, this would constitute an incentive for an OGEC to take the lead and defend falling prices.[229] It remains to be seen to what extent the GECF will develop into an OGEC. It is not clear how such a cartel would fix the gas price, possibly enacting price-fixing mechanisms or imposing production quantitative restrictions. In reality, traded gas is often subject to long-term contracts that feature rigid pricing terms supported by international commercial provisions. As one might expect, government interference in pricing terms would amount to a breach of such agreements, triggering international arbitration in order to settle the contractual dispute.

On a different level, U.S. President Barack Obama and former Chinese General Secretary Hu Jintao acknowledged the importance of fostering cooperation in shale gas development by establishing an agreement in the form of the Global Shale Gas Resource Initiative (GSGI) in November 2009. This agreement provides U.S. assistance to assess, develop, and promote investment in shale gas reserves, and to help develop operational best practices and effective environmental safeguards.[230] The goal of the GSGI is to assist countries seeking to develop their own unconventional gas resources while balancing energy security and environmental concerns.[231] So far, partnerships have been arranged with India, Poland, and China. Chinese state-owned gas producers have entered into major transactions with large international players to develop shale gas reserves in China and to exploit shale gas reserves in Western Canada and the United States.[232]

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228. INT'L ENERGY AGENCY, KEY WORLD ENERGY STATISTICS 13 (2015), https://www.iea.org/publications/freepublications/publication/key-world-energy-statistics-2015.html.

229. *See* STEVENS, *supra* note 17, at 23 (remarking that this was precisely the mechanism that led to the creation of OPEC in 1960); Farah & Cima, *supra* note 19.

230. *See* Melanie Hart & Daniel J. Weiss, *Making Fracking Safe in the East and West, Environmental Safeguards on Shale Gas Production Needed as China Begins Development*, CTR. FOR AM. PROGRESS (Oct. 21, 2011), https://www.americanprogress.org/issues/green/report/2011/10/21/10407/making-fracking-safe-in-the-east-and-west/.

231. David L. Goldwyn, *Briefing on the Global Shale Gas Initiative Conference* (Aug. 24, 2010), http://m.state.gov/md146249.htm.

232. *See* KPMG GLOB. ENERGY INST., *supra* note 51, at 11.

Whether the GSGI can provide a regulatory model to develop unconventional natural gas resources in an environmentally sensitive manner remains to be seen. In that respect, appropriateness of the U.S. legal framework as a model scheme is still debatable, given the problem that shale gas is creating in the United States, especially in relation to the environment. While good progress on the exploration and development aspects of this agreement has been made, environmental cooperation is still lacking. This is in part due to the fact that the United States is still struggling to design the most adequate domestic regulatory framework for safeguards. Environmental protection is not the priority for either side, as they do not want to jeopardize the potential of China's shale gas by firmly pursuing environmental protection. At the same time, U.S. energy companies engaged in these bilateral exploration and development projects aimed at exchanging assessment and extraction technology for gaining Chinese commercial market access. On the other side, China strives to transfer technology from the United States, which often implies intellectual property rights concerns.[233]

Almost all fracking technology and experience are owned by U.S. companies, and China needs to learn from them in order to develop its own shale gas services and industry. To this end, Chinese oil companies have already started investing in the U.S. shale market. Namely, CNOOC has joined with Chesa-

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233. *Zhong mei ye yan qi he zuo: ge you suo tu* [*China-United States Shale Gas Coopeation: Each Side Has its Own Plans,* ZHONGGUO HUAGONG BAO [CHINA CHEMICAL INDUSTRY NEWS), (June 8, 2010), http://www.cheminfo.gov.cn/ZXZX/page_info.aspx?id=276022&Tname=hgyw &c=10; Clifford M. Gross, *The Growth of China's Technology Transfer Industry Over the Next Decade: Implications for Global Markets,* J. TECH. TRANSFER 1 (2012); Arnaud De La Tour et al., *Innovation and International Technology Transfer: The Case of the Chinese Photovoltaic Industry,* 39 ENERGY POL'Y 761 (2011); Bo Wang, *Can CDM Bring Technology Transfer to China?—An Empircal Study of Technology Transfer in China's CDM Projects*, 38 ENERGY POL'Y 2572 (2010); Bronwyn H. Hall & Christian Helmers, *The Role of Patent Protection in (Clean/Green) Technology Transfer* (Nat'l Bureau of Econ. Research, Working Paper No. w6323, 2010); David G. Ockwell et al., *Intellectual Property Rights and Low Carbon Technology Transfer: Conflicting Discourses of Diffusion and Development,* 20 GLOBAL ENVTL. CHANGE 729 (2010); Rasmus Lema & Adrian Lema, *Technology Transfer? The Rise of China and India in Green Technology Sectors,* 2 INNOVATION & DEV. 23 (2012).

peake Energy on production ventures,[234] and Sinopec partnered with Devon Energy in a similar deal.[235] These agreements were minority interests in actual gas production, and constituted investments to export fracking know-how and technologies through participation in the exploration and production team.[236] However, the way China will overcome the technology and experience barriers is still open to debate. U.S. techniques are not very mature, and may fail to answer China's know-how needs. Also, Chinese shale gas is found in deeper reserves, while shale gas in the United States is mostly distributed in plains and hidden shallowly.[237] The hidden depth and the peculiar geological context make China's exploitation much more challenging. Moreover, given that China's ultimate goal is to achieve and maintain energy security by developing its domestic natural resources, it cannot exclusively bid on U.S. technology and expertise. Accordingly, it will continue to invest in major foreign energy companies (as happened with Chesapeake Energy and Devon Energy), and then it will import early models of hydraulic fracturing in order to develop its own domestic

234. Joe Carroll & Benjamin Haas, *Sinopec's U.S. Shale Deal Struck at Two-Thirds' Discount*, BLOOMBERG BUS. WEEK, (Feb. 26, 2013, 4:03 PM), http://www.bloomberg.com/news/articles/2013-02-25/sinopec-to-buy-chesapeake-oil-and-gas-assets-for-1-02-billion.

235. Angel Gonzalez & Ryan Dezember, *Sinopec Enters U.S. Shale*, WALL ST. J. (Jan. 4, 2012), http://www.wsj.com/articles/SB10001424052970203550304577138493192325500.

236. Chesapeake Energy concluded a deal that transferred 33 percent of its license rights in the United States to CNOOC in exchange for Chinese financial support necessary to guarantee continued operations on the Chesapeake-owned sites. Energy expert Elias Hinckley underlines that the price of fracking technologies and extraction expertise is going to rise in the United States as Chinese firms bid to take possession of the necessary technology and expertise to hasten their own shale gas revolution. Hinckley remarks:

> How significant the technology and expertise price increases will be remains to be seen, but the Chinese appetite, and the likely pace of acquisition over the next few years will likely have a material impact not just on service and technology, but also on the cost of production here in the U.S.

Elias Hinckley, *The Road to Chinese Shale Gas Goes Through the U.S.*, ENERGY TRENDS INSIDER (Dec. 12, 2012), http://www.energytrendsinsider.com/2012/12/12/the-road-to-chinese-shale-gas-goes-through-the-u-s/.

237. Wang & Krupnick, *supra* note 186.

model of fracking technology by reverse engineering the technology.[238]

U.S. companies have a strong interest in supporting bilateral environmental protection efforts, as a shale gas environmental accident in China would not only affect the Chinese economy, but would also augment opposition to fracking in the United States.[239] Moreover, if China does not comply with best practices in capturing GHG, shale gas development will increase China's emissions instead of reducing them. Further efforts are needed to guarantee that China optimizes the advantages from shale gas development, that is to say decreasing oil imports and pollution, while reducing the environmental hazards. Within U.S.-China bilateral cooperation on shale gas development, a collaborative dialogue has already commenced, engaging governments, NGOs, the private sector, researchers, and academia. This exchange should be reinforced, and China should focus on importing and developing environmentally-friendly technologies, best practices, and a comprehensive regulatory framework to foster safe and secure exploitation of its shale gas resources.

V. THE PROSPECTS FOR SHALE GAS IN CHINA BETWEEN REGULATORY INTERVENTIONS AND NEW GEOPOLITICAL BALANCES

As shale gas radically impacts the supply and demand of the world's energy mix and market, new geopolitical factors must be assessed, taking into account that, as far as China is con-

238. Historically, reverse engineering has been used by the Chinese in nuclear reactor technology, see Joe Mcdonald, *China Sets Sights on New Global Export: Nuclear Energy*, PHYS.ORG (Aug. 24, 2016), http://phys.org/news/2016-08-china-sights-global-export-nuclear.html#jCp ("China's government-run nuclear industry is based on foreign technology but has spent two decades developing its own with help from Westinghouse Electric Co., France's Areva and EDF and other partners.").

239. As happened following the Fukushima nuclear meltdown in Japan, which increased American and European opposition to nuclear power. Bettina B. F. Wittneben, *The Impact of the Fukushima Nuclear Accident on European Energy Policy,* 15 ENVTL. SCI. & POL'Y 1 (2012); Howard L. Hall, *Fukushima Daiichi: Implications for Carbon-free Energy, Nuclear Nonproliferation, and Community Resilience,* 7 INTEGRATED ENVTL. ASSESSMENT & MGMT. 406 (2011). On Germany's nuclear energy phaseout, see Jahn Detlef & Sebastian Korolczuk, *German Exceptionalism: The End of Nuclear Energy in Germany!,* 21(1) ENVTL. POL'Y 159 (2012).

cerned, economic and demographic growth will increase pressure on global energy supplies, and thus all fuel sources will have to be exploited.[240] China has historically depended on fuel imports from politically sensitive regions, restraining its foreign policy options.[241] This predominant dependence on foreign energy poses different risks: disruptions to its imported energy, sustained and extremely volatile energy prices and a clash between China's foreign policy interests and its overseas energy interests.[242] Copious shale gas production can help the country acquire security of energy supply, which could lead to both a dramatic and radical change in its relationships with other nations. The emergence of this new resource in North America is already changing the dynamics of the global gas business and energy geopolitics, demonstrating that the gas market is truly global.[243]

Indeed, the energy market is currently affected by a surplus of production. The principal cause of this surplus originates in the mass production of shale gas from the United States, which is now closer to the goal of energy independence. Energy demand cannot absorb this excess in resources produced, particularly as demand has decreased because of the current global economic recession, especially in Europe. In other words, U.S. investment in the industry of fracking is bearing fruit for which

240. Globally, the shale gas revolution will also have important geopolitical consequences, for instance, reducing Europe's overdependence on its two present dominant gas suppliers, Qatar and Russia. Marjolein de Ridder & Sijbren de Jong, *The "Game changer": Geopolitical Implications of the 'Shale Gas Revolution'* 9 (2013), http://www.atlcom.nl/upload/AP_6_2013_De_Ridder___De_Jong.pdf.

241. In light of the absence of a sustainable supply of conventional fossil energy and excessively rapid growth of demand for energy, Chinese energy external dependence is still high. On this point, Zha Daojiong points out the relevance of energy efficiency measures, remarking that "Dependence on foreign sources of energy supply is in itself a threat to China's energy security; the key threat is the ever-growing consumption without significant improvement in energy efficiency." Zha Daojiong, *China's Energy Security: Domestic and International Issues*, 48 SURVIVAL 179 (2006).

242. See Bo Kong, *supra* note 136.

243. Shale gas can be a strategic tool to deter a strengthening of the political risk the global oil market currently faces while reducing "U.S. and Chinese dependence on Middle East natural gas supplies, lowering the incentives for geopolitical and commercial competition between the two largest consuming countries and providing both countries with new opportunities to diversify their energy supply." MEDLOCK, *supra* note 201, at 13.

there is excess supply of oil and gas in a time in history when the global economy is struggling to recover.[244]

The excess production has caused a collapse in oil prices and natural gas, which has not, however, been followed by an effort by Organization of the Petroleum Exporting Countries (OPEC) to cut production. International experts in the energy market are trying to understand the reasons behind this strategy. One hypothesis, which sees in the failure to cut production by OPEC an attempt to exclude from the market competition of U.S. shale gas, is far-fetched. Indeed, hydrocarbons extracted from shale rock in the United States produce income at prices between $40 and $115, implying that, if OPEC could keep crude oil at $70 per barrel, competition of shale gas in the United States would be strongly affected.[245] Such a pricing strategy would slow the development of the new generation of western mining technologies that are slowly eroding the bargaining and geopolitical power of the members of OPEC.[246] Protracted low prices would produce a financial return which would defeat the costly investment required for starting the production of shale gas and would create further instability. From a different perspective, shale gas can be a strategic tool to discourage the rise of the political risk that the global oil market is facing, while reducing "dependence on the US and Chinese natural gas reserves of the Middle East, limiting the incentives for geopolitical competition and trade between the two main consuming countries and providing both new opportunities to diversify their energy reserves."[247]

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244. *See* Leonardo Maugeri, *Troppa offerta di greggio e non c'è il coraggio di tagliare la produzione* [*Too Much Supply of Crude Oil and There is Not the Courage to Cut Production*], REPUBBLICA.IT (Nov. 29, 2014), http://www.repubblica.it/economia/2014/11/29/news/leonardo_maugeri_troppa_offerta_di_greggio_e_non_c_il_coraggio_di_tagliare_la_produzione-101702664/?refresh_ce.

245. On oil price data, see Arthur Berman, *Why the Oil Price Collapse is U.S. Shale's Fault*, OIL PRICE (Apr. 6, 2015, 10:08 PM), http://oilprice.com/Energy/Oil-Prices/Why-The-Oil-Price-Collapse-Is-U.S.-Shales-Fault.html.

246. In this vein, see Federico Fubini, Petrolio, *tutti contro tutti così la strategia saudita indebolisce Usa e Russia* [Oil-for-All as the Saudi Strategy Weakens the US and Russia], REPUBBLICA.IT (Nov. 29, 2014), http://www.repubblica.it/economia/2014/11/29/news/petrolio_tutti_contro_tutti_cos_la_strategia_saudita_indebolisce_usa_e_russia-101679458/.

247. MEDLOCK, *supra* note 201, at 13.

In the light of the analysis above, some essential elements of potential Chinese shale gas development should be pointed out. First, there is a need to design a comprehensive and conducive regulatory environment, legally implemented, which would take into consideration the environmental hazards related to shale gas exploration and production. Shale gas production in China is in its infancy, and a sound regulatory system is required to assure long-term exploitation. Overarching effective unitary regulation would reduce uncertainty in the gas market and foster future investments offering attractive terms to private investors.[248] Second, China needs to tackle its unsatisfactory record of environmental enforcement which jeopardizes the capacity of existing laws to prevent the downside of hydraulic fracturing. This can be accomplished through adoption of transparency initiatives and mandatory disclosure of environmental information. This would also help reduce the friction between Beijing's concerns over energy security and opposition by reluctant local communities worried about the environmental costs of shale gas exploration and extraction. Infrastructure development and technology transfer are equally needed, and the previous experience of the United States in this sector can be of great help to the development of Chinese shale gas industry. As part of this strategy, China's Ministry of Resources has invited some major oil and gas companies to pitch for shale gas exploration work, granting licenses for exploration in western China.[249]

The Chinese national political climate for shale gas appears to be positive as well. In March 2012, the first five-year shale gas development plan for the period 2011–2015 was jointly released by the NDRC, the MOF, the Ministry of Land and Resources, and the National Agency of Energy. It called for development of a policy framework for regulation of the country's shale gas sector, and it ambitiously estimated that production would reach 80 billion cubic feet in 2020 from production at the time of zero.[250] In this vein, according to the plan, China will develop projects for the "assessment for shale and confirming

248. On the other hand, rigid environmental legislation could inhibit shale gas exploration. This environmentally friendly over-regulation, however, does not appear to likely to develop in China.

249. *See* KPMG GLOB. ENERGY INST., *supra* note 51, at 11.

250. "Development Plan for Shale Gas (2011-2015) (Fa Gai Neng Yuan (2012) No. 612)" (页岩气发展规划 (2011-2015) (发改能源 (2012) 612号)).

the current reserve estimates."[251] A National Shale Gas Development Program has been adopted, in which great importance is given to research and development for technology, exploration, and development of shale gas in light of the Thirteenth Five Year Plan (2016–2020), which will greatly emphasize the importance of exploring unconventional and alternative energy sources. As long as China is pursuing joint ventures with foreign enterprises to acquire know-how in shale gas exploration and extraction, it seems probable that its leadership will continue to encourage shale gas commercial exploitation. An actual shale gas market is expected to develop over an extended period of time; and although government support appears sound, it is hard to foresee how the market will shape until major policy decisions on pricing, infrastructure development, and competition have been announced.

It is in this context of uncertainty that we should see the agreement signed in May 2014, in Shanghai and Russia (or rather, by the two state-owned energy companies, CNPC. It is a thirty-year agreement that is binding on Russia to provide to China 38 billion cubic meters of gas per year starting in 2018.[252] The still uncertain forecasts for exploitation of unconventional gas necessitate an increase in imports of natural gas. Following the agreement, China will be able to take advantage of additional supply to meet its growing demand for natural gas, and thus face the need to reduce the supply of coal in national energy demand, currently equal to two-thirds of it.[253]

CONCLUSION

In conclusion, successful shale gas development in China would meet domestic demand, and this new resource may grant China stronger bargaining power with gas exporters on issues such as price, which could narrow the gap between North American and Asian natural gas prices. The strategic signifi-

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251. *Id.*

252. James Paton & Aibing Guo, Russia, *China Add to $400 Billion Gas Deal With Accord*, BLOOMBERG BUS. WEEK, (Nov. 10, 2014), http://www.bloomberg.com/news/articles/2014-11-10/russia-china-add-to-400-billion-gas-deal-with-accord.

253. On the agreement, see Richard Weitz, *The Russia-China Gas Deal: Implications and Ramifications*, WORLD AFF., Sept.–Oct. 2014, http://www.worldaffairsjournal.org/article/russia-china-gas-deal-implications-and-ramifications.

cance of China in the shale gas revolution is undeniable in light of the current rise of energy prices and struggle to reduce harmful emissions in order to contain climate change. It remains to be seen whether this "bridge fuel" will be a viable resource capable of contributing to greater energy security, while being developed in an environmentally sound manner in a country with a $12 trillion economy that is deeply involved in the global economy.