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A Comparison Between Shale Gas in China and Unconventional Fuel Development in the United States: Health, Water and Environmental Risks

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Summary

China is appraised to have the world's largest exploitable reserves of shale gas, although several legal, regulatory, environmental and investment-related issues will likely restrain its scope. China's capacity to successfully face these hurdles 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 decrease reliance on imported oil and coal, while attempting to meet growing energy demand and maintain a certain level of resource autonomy. The development of the unconventional natural gas extractive industry will also endow China with further negotiating power to obtain more advantageous prices from Russia and future liquefied natural gas (LNG) suppliers. This paper, adopting a comparative perspective, underlines the trends learned from unconventional fuel development in the United States, emphasizing their potential application to the Chinese context in light of recently signed production-sharing contracts between qualified foreign investors and China. The wide range of regulatory and enforcement problems in this matter are accrued by an extremely limited liberalization of gas prices, lack of technological development, and political hurdles curbing the opening of resource extraction to private investors. These issues are exacerbated by concerns related to the risk of water pollution deriving from mismanaged drilling and fracturing, absence of adequate regulation framework and industry standards, entailing consequences on social stability and environmental degradation.

Keywords: Shale Gas, Unconventional Fuel, China, U.S.A., Health, Water, Environmental Risks

JEL Classification: A12, A13, D40, D62, D81, F10, F13, F18, H23, K32, K33, Q4, Q40, Q41, Q42, Q43, Q48, F1, F13, F40, L95, Q3, Q30, Q32, Q33, Q25

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

Dr. Paolo D. Farah and Riccardo Tremolada*****

1. INTRODUCTION

The significant growth in the production of natural gas from shale formations constitutes one of the most relevant developments in the energy sector, which has been made possible by the reduction of production costs and the overcoming of technological barriers. Indeed, 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 resulted in energy experts describing shale gas as a "bridge fuel" to carbon-free renewable resources as our primary source of energy.[1]

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Furthermore, shale formations are found in almost every region of the globe, thus the potential for shale gas development is of great relevance.[2] Although shale gas represents a revolutionary element in the global energy framework, several regulatory and environmental concerns related to 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.[3] As the "shale gas revolution" that took place in the United States has highlighted, menacing human health and environmental concerns continue to dog shale gas development. In that respect, given the global scope of its potential, it is crucial to assure that the development of shale gas resources will be carried out in an environmentally sound manner.[4] 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. Being the country the largest source of increases in greenhouse gas 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. However, China features the absence of comprehensive legal instruments addressing the potential environmental hazards of shale gas extraction and weak enforcement of environmental laws and regulations. This paper will examine: 1) the implications on the world's energy market and

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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 (1) OXFORD REVIEW OF ECONOMIC POLICY 117-143 (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 POLICY 442–453 (2013). An interesting comparative analysis between shale gas development in China and the United States has been carried out by Joshua Harvey and Yang Min in the framework of the Vermont Law School -China Partnership for Environmental Law. See in particular, Joshua Harvey & Yang Min, *The Unconventional Promise and Problems* of *Shale Gas Development in the US and China*: *A Comparative Study* (2011), available at http://www.vermontlaw.edu/Documents/Yang%20Min%20Josh%20Harvey%20with%20logo%20and%20disclaimer.pdf

[2] Christophe McGlade, Jamie Speirs, & Steve Sorrell, *Unconventional Gas–A Review of Regional and Global Resource Estimates* 55 ENERGY 571–584 (2013).

[3] 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 open the fractures. Fracturing fluid is a mixture of about 90% water, 9.5% sand, and 0.5% other chemical additives. See generally Environmental Protection Agency (2010). Environmental Protection Agency, *Hydraulic Fracturing Research Study*, 2010.

[4] *See* Hannah Wiseman, *Untested Waters: The Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation* 20 FORDHAM ENVIRONMENTAL LAW REVIEW 115, 116 (2009); Eleanor Stephenson, Alexander Doukas, & Karena Shaw, *Greenwashing Gas: Might a 'Transition Fuel' Label Legitimize Carbon-intensive Natural Gas Development?* 46 ENERGY POLICY 452-459 (2012).

its relevance *vis-à-vis* energy security; 2) it will carry out a comprehensive review of the current development of shale gas exploration in China and its strategic significance in the global energy scenario; 3) it will also look at the loopholes and inconsistencies in the current Chinese legal and regulatory framework, including the institutional shortcomings that hinder effective enforcement of environmental provisions, the pricing and fiscal regime and the current barriers to foreign investments' access to the Chinese energy market, which is in strong contradiction with the need for technology and know-how; 4) it reviews the U.S. experience to date and questions whether this could constitute a valuable model for future shale gas exploitation and commercialization in China. In that perspective, this paper will argue that the current applicable 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. This study aims to feed into and inform the ongoing debate on shale gas's prospects and China's strategic role in the global energy picture. It concludes that a comprehensive legal and regulatory change is necessary in order to foster an environmental sound development of the shale gas sector in China in light of the need to increase energy security, to achieve the country's future energy and environmental objectives, and to assure a beneficial economic growth and societal development.

2. GOING UNCONVENTIONAL: THE REVOLUTIONARY ROLE OF SHALE GAS THROUGH THE PRISM OF CHINA'S ENERGY MIX

The potential for shale gas development is being explored in several countries.[5] 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[6] and horizontal drilling,[7] which create fissures in the rock allowing the gas to flow more easily through it. Besides shale gas

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

[6] For a definition of "hydraulic fracturing", see *supra* note 3.

[7] Horizontal drilling involves drilling a vertical well to the desired depth and then drilling laterally to access a larger portion of the reservoir. George King, *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, The Woodsland, texas, U.S.A., February 6-8, 2012.

resources, there are other types of unconventional gas reservoirs: tight gas[8] and coal bed methane (CBM)[9]. That said, the present study concentrates on shale gas because of the recent enormous increase in shale gas production and its potential for China's energy mix and supply.[10]

Shale gas is revolutionizing the world energy markets and industry. Vast deposits are being discovered throughout the world. China is aware of the role of unconventional gas[11] as a carbon-friendly energy source and pivotal element in achieving the country's future energy and environmental objectives: increasing energy security, decreasing greenhouse gas emissions,[12] and ameliorating domestic air quality while simultaneously empowering the country to persevere a

[8] Tight gas refers to natural gas that is trapped in sandstones. For the significance of this energy sources in China, see Dai Jinxini, Ni Yunyan & Wu Xiaoqi, *Tight Gas in China and Its Significance in Exploration and Exploitation 39(3)* PETROLEUM EXPLORATION AND DEVELOPMENT 277-284 (2012).

[9] CBM is natural gas that is produced from coal seams, which act as the source and reservoir for the natural gas. China's focus has historically 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 INTERNATIONAL JOURNAL OF COAL GEOLOGY 93-108 (2012).

[10] China's potential unconventional gas reservoirs are significant, although many still need to be exactly estimated. The political support to 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* INTERNATIONAL ENERGY AGENCY, MEDIUM-TERM OIL & GAS MARKETS 185 (2010). To achieve this goal, China will have, inter alia, to acquire fracking technology and expertise. In that sense, the state-owned company Sinopec has already launched a 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* INTERNATIONAL ENERGY AGENCY, MEDIUM-TERM OIL & GAS MARKETS 185, 188 (2010).

[11] The term "unconventional gas" is here used to indicate shale gas, which has been acknowledged as the most promising unconventional gas, the other ones being tight gas and coalbed methane.

[12] According to the Kyoto protocol's emission reduction obligations, the Chinese government announced on 25th November 2009 that China's unit GDP CO2 emissions in 2020 compared with that in 2005 will decreased by 40%-45%. Margret Kim & Robert Jones, *China's Energy Security and the Climate Change Conundrum* 19(3) NATURAL RESOURCES & ENVIRONMENT 3 (2005); Deng Haifeng, *Legal Interactive Mechanism on Climate Change: A Comparative Study of China and U.S. Experiences* 8 US-CHINA LAW REVIEW 431, 431–444 (2011); Paul Howard, *Harmony' in China's Climate Change Policy,* in CLIMATE CHANGE AND GROWTH IN ASIA (Moazzem Hossain & Eliyathamby Selvanathan eds., Edward Elgar, 2011).

beneficial economic growth and societal development.[13] A 2013 assessment of international shale gas resources issued by the U.S. Energy Information Administration[14] cited technically recoverable shale gas resources in China at 1,175 trillion cubic feet,[15] nearly 50 percent more than the United States.[16] 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. The rigid structure of China's state-controlled oil and gas industry hampers efforts to exploit reserves since the current absence of competition between the three state-owned energy giants (CNPC, Sinopec and PetroChina) is not conducive to a fair allocation of resources. In that sense, the country's current energy regulation features over-regulation of the energy market, a fragmented system of regulation and insufficient environmental regulation.[17] Moreover, numerous Chinese investments into North American shale basins show that Beijing's engagement in exploring the potential of shale gas resources is concrete as China is exponentially building its shale gas capacity in order to achieve energy security and influence in the world's gas pricing regimes.[18] In that sense, what appears to emerge is a growing Chinese

13 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 AND MANAGEMENT 1357-1367 (2004). On the relationship between economic growth and social development, see generally Gheorhe H. Popescu, *The Social Evolution of China's Economic Growth* 1 CONTEMPORARY READINGS IN LAW AND SOCIAL JUSTICE 88-93 (2013).

[14] The Energy Information Administration is an independent arm of the U.S. Department of Energy.

[15] Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States (2013 report). See also Li Shizhen, *The Status of World Shale Gas Exploration and Development and Implications for China* 6 GEOLOGICAL BULLETIN 918-924 (2010). (in Chinese).

[16] China has an estimated 1,115 Tcf of risked, technically recoverable shale gas, 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. Additional risked, 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 already are underway in China, focused in the Sichuan Basin and Yangtze Platform areas and led by PetroChina, Sinopec, and Shell and 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 2.

[17] Xin Qiu & Honglin Li, *Energy Regulation and Legislation in China* 42 ENVIRONMENTAL LAW REPORTER 10678 (2012).

[18] Globally, States engage in multilateral or bilateral inter-State relations to pursuit 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 and Multilevel Approach,* 20 (6) EUROPEAN ENERGY AND ENVIRONMENTAL LAW REVIEW, 232-234 (2011); Rafael Leal-

engagement in inter-State relations in order to guarantee a steady energy supply for its ever-increasing domestic needs.[19] At the moment natural gas demand continues to exceed supply, making China a net importer, but domestic production has been burgeoning,[20] increasing the share of natural gas in total energy requirements from 2 percent to 4 percent, and planning to reach 8 percent by 2015 and 10 percent by 2020.

However, carrying out an assessment of the development of shale gas industry in China, the current applicable legal framework is neither sufficient nor satisfactory, given what is at stake. China still has to adequately delineate a policy framework regarding energy regulation and physical infrastructures, pricing mechanisms, 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, it 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 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 could bid on gas drilling project, namely, China National Off-shore Oil Corporation, Sinopec,PetroChina, Yanchang Petroleum, China United Coalbed Methane Corporation and Henan CBM. The exclusion of foreign companies from those eligible to obtain production licenses aimed at retaining control over the scope of investments and the production ratio.The second round of tendering was held in October 2012 and it opened up bidding to state-owned enterprises in other industries and to privately-held Chinese investment entities as well (Sinochem, Zhenhua Oil) in order to foster greater competition and innovativeness in the infant shale gas industry. However, the Chinese government still has enormous leeway in

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Arcas & Andrew Filis, *The Fragmented Governance of the Global Energy Economy: a Legal-Institutional Analysis* 6(4) JOURNAL OF WORLD ENERGY LAW AND BUSINESS 1-58 (2013).

[19] Andreas Goldthau, *Energy Diplomacy in Trade and Investment in Oil and Gas* in GLOBAL ENERGY GOVERNANCE : THE NEW RULES OF THE GAME 25–47 (Goldthau & Witte eds, Brookings Institution Press, 2010).

[20] 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 continuingly increasing domestic need, China is also implementing its energy infrastructure network. In that respect, the 4,200-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 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 2; Ruud Weijermars & Crispian McCredie, *Assessing Shale Gas Potential*, PETROLEUM REVIEW, Oct. 2011.

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.[21] Nevertheless, foreign companies are not able to bid or 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 partnerships with foreign investors.[22] Accordingly, 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.

What is more, it remains to be seen what the implications will be in terms of environmental costs. Shale gas is obtained through hydraulic fracturing (or "fracking"), a controversial extracting technology which creates, as highlighted by the shale gas boom that took in place in the U.S.,[23] 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 accrued 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 minimizing environmental damages related to the process of shale gas extraction and achieving 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 have taken the lead in exploration, development, technology, production, and export of shale gas, as we shall

[21] Christina Larson, *China's Shale-Gas Potential and Peril*, BLOOMBERG BUSINESS WEEK, April 18, 2013.

[22] KPMG Global Energy Institute, *Shale Gas*: *Global*. *M&A Trends*, KPMG INTERNATIONAL, May 2012.

[23] 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".* DANIEL YERGIN, THE QUEST: ENERGY SECURITY AND THE REMAKING OF THE MODERN WORLD (New York: The Penguin Press, 2011). See Wiseman, *supra* note 4; Angela C. Cupas, *The Not-So-Safe Drinking Water Act: Why We Must Regulate Hydraulic Fracturing at the Federal Level*, 33 WILLIAM & MARY ENVIRONMENTAL LAW AND POLICY REVIEW 605 (2009).

explore below. Consequentially their experience could be helpful for other countries, such as China, in order to develop their own shale gas industries.

3. A TRANSITIONAL FRAMEWORK TO ALTERNATIVE ENERGY?

Shale gas has been widely referred as a "bridge fuel", implying its capability to move towards the replacement of hydrocarbons with carbon-free renewable resources as our primary source of energy.[24] This concept acknowledges that renewable resources cannot replace hydrocarbons as our 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. In that respect, what appears to emerge is that, at the moment, renewable resources are less cost-competitive than fossil fuels, in particular natural gas.[25] Moreover, renewable resources present further downsides in addition to their high costs, which relates to the need of installing thousands of miles of new transmission lines requiring onerous investments and burdensome regulatory approvals. With the European Union and the United States being a case in point and examining the efforts 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. That said, given the ongoing financial recession, those subsidies and mandates are unlikely to be granted in the future. Rather, many European countries have already either reduced or eliminated those subsidies.[26]

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[24] Hanna Mäkinen, *Shale Gas–a Game Changer in the Global Energy Play*, 1 BALTIC RIM ECONOMIES (2010); Amy Myers Jaffe, *Shale Gas Will Rock the World*, WALL STREET JOURNAL, May 10, 2010; PAUL STEVENS, THE 'SHALE GAS REVOLUTION': HYPE AND REALITY (London: Chatham House, 2010); Noam Lior, *Sustainable Energy Development with Some Game-Changers*, 40(1) ENERGY 3-18 (2012); Martin Wolf, *Prepare for a Golden Age of Gas*, FINANCIAL TIMES, Feb. 22 (2012).

[25] It costs two to five times as much to generate electricity through 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 use of a renewable resource is worth only about 25% as much as a unit of electricity generated through use of gas. Paul L. Joskow, *Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies*, 100(3) American Economic Review: Papers & Proceedings 238–241 (2011) available at http://web.mit.edu/ceepr/www/publications/reprints/Reprint_231_WC.pdf ; Paolo Davide Farah & Elena Cima, Energy *Trade and the WTO: Implications for Renewable Energy and the OPEC Cartel*", 16 (3) JOURNAL OF INTERNATIONAL ECONOMIC LAW, 707-740 (September 2013).

[26] For instance, Portugal and Spain took 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.

On the other hand, displacement of coal with natural gas, including shale gas, as a generating fuel diminishes emissions of carbon dioxide by about fifty per cent.[27] 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 displacing coal with natural gas, but that we will entirely replace all hydrocarbons with carbon-free renewable resources in the longer term.[28] Clearly the practicality of this scenario is dependent on the ability to take measures adequate to assure society that hydraulic fracturing of shale basins can be carried out with low environmental costs. China is likely to greatly benefit from shale gas. The International Energy Agency foreshadows that China will consume more gas than the entire EU by 2035.[29] Being the country the largest source of greenhouse gas emissions and the largest source of increase in greenhouse gas 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.[30]

However, shale gas carries the danger of slowing down investment in renewable energies. Particularly, some critics suggest that the industry's focus on developing shale gas and other unconventional sources is removing attention and capitals from the development of renewables as low-cost power generated with copious natural gas supplies and this could frustrate the economic viability of wind, solar and geothermal projects, eventually delaying the shift to renewable energies by many years.[31] Indeed, in the U.S. shale gas as a source of low-priced electric power created a

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[28] Richard J. Pierce, Jr, Natural Gas: A Long Bridge to a Promising Destination, 32 UTAH ENVIRONMENTAL LAW REVIEW 245 (2012). See also Daniel P. Schrag, *Is Shale Gas Good for Climate Change?*, 141(2) DÆDALUS, THE JOURNAL OF THE AMERICAN ACADEMY OF ARTS & SCIENCES (2012). On the other side, unconventional natural gas production is noted for its potential for significantly large quantities of methane leakage, which is a potent greenhouse gas . 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, Yan He & Erica Pohnan, *Lessons Learned: A Path Toward Responsible Development of China's Shale Gas Resources*, Natural Resources Defense Council 6 (2012). Arguing that dynamic governance innovation can facilitate climate-energy-water balancing to address natural gas governance gaps. Elizabeth Burleson, *Climate Change and Natural Gas Dynamic Governance*, 63 (4) CASE WESTERN RESERVE LAW REVIEW (2013).

[29] International Energy Agency, 2011. *Are We Entering a Golden Age of Gas?*, Special Report (International Energy Agency, OECD, Paris, 2011).

[30] 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 xix (Dodson ed., New York, Springer, 2010).

[31] In light of the great potential for investments in carbon markets, renewable energy sources and low carbon technologies, it clearly appears that international investment, renewables and climate change are interdependent concepts. On this point, see Miles, investigating recent investor challenges to environmental regulation and suggesting

more difficult competitive environment for new wind projects.[32] 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.[33] In our view, 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 fuel 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.[34] 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.[35] Finally, further actions would require the development of a real-time pricing mechanism for electricity[36] and the reduction of

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that a similar approach to climate change-related regulation can be expected. Kate Miles, *International Investment Law and Climate Change: Issues in the Transition to a Low Carbon World,* Society of International Economic Law (SIEL) Inaugural Conference, July 2, 2008, available at SSRN: http://ssrn.com/abstract=1154588 or http://dx.doi.org/10.2139/ssrn.1154588.

[32] See Yergin, *supra* note 23.

[33] This was confirmed by Chief economist of the International Energy Agency (IEA), Fatih Birol, who stated that "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*, THE GUARDIAN, Jun.6, 2011, available at http://www.theguardian.com/environment/2011/jun/06/natural-gas-climate-change-no-panacea.

[34] 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 so can act as an effective hedge against the intermittency of renewables. The Center for Climate and Energy Solutions (C2ES), June 2013, Leveraging Natural Gas to Reduce Greenhouse Gas Emissions, Summary Report (The Center for Climate and Energy Solutions (C2ES), June 2013), available at http://www.c2es.org/publications/leveraging-natural-gas-reduce-greenhouse-gas-emissions.

[35] William D. Nordhaus, *To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming*, 1(1) REVIEW OF ENVIRONMENTAL ECONOMIC POLICY 26-44 (2007); Liang Qiao-Mei, Ying Fan, & Yi-Ming Wei, *Carbon Taxation Policy in China: How to Protect Energy-and Trade-Intensive Sectors?* 29(2) JOURNAL OF POLICY MODELING 311-333 (2007).

[36] Mark G. Lijesen, *The Real-Time Price Elasticity of Electricity* 29(2) ENERGY ECONOMICS 249-258 (2007); Stephen P. Holland & Erin T. Mansur, *Is Real-Time Pricing Green? The Environmental Impacts of Electricity Demand Variance* 90(3) THE REVIEW OF ECONOMICS AND STATISTICS 550-561 (2008); Hunt Allcott, *Rethinking real-time electricity pricing* 33(4) RESOURCE AND ENERGY ECONOMICS 820-842 (2011).

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. Recent studies suggest that these losses can be limited by the use of best technology, but cannot be completely avoided.[37] In that respect it is crucial to precisely measure the GHGs emissions from natural gas production and consumption to minimize emissions reductions along the entire natural gas value chain.[38] As technologies for producing shale gas continue to advance and the industry is growing in scale, wider collaboration on R&D issues among governmental agencies and international energy governance institutions is required.

In the light of the aforesaid, a growing body of scientific research questions how shale gas could ever be a transitional fuel able to shift us from our current over-reliance on fossil fuels to a greater use of sustainable renewable energy, given its carbon intensity and level of investment needed.[39] Furthermore, shale gas could attract costly regulation. In fact, analyzing the current energy consumption forecasts, fossil fuels are likely to constitute a significant portion of general energy supplies into the foreseeable future. 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 greatly augment costs across the entire oil and gas industry, with dramatic repercussions on highly cost-sensitive shale gas investments, projects and operations.[40]

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[37] 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, Renee Santoro, & Anthony Ingraffea, *Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations* 106(4) CLIMATIC CHANGE 679-690 (2011).

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

[39] On this point, Nobuo Tanaka, executive director of the International Energy Agency (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 33. Indeed, according to studies carried out by the IEA, the development of the shale gas industry would put our CO2 emissions on a "trajectory consistent with a probable temperature rise of more than 3.5 degrees Celsius in the long term". International Energy Agency (IEA), May 2012, Golden Rules for a Golden Age of Gas, International Energy Agency May 2009, at 91, available at http://www.worldenergyoutlook.org/goldenrules/.

[40] TATSU KAMBARA & CHRISTOPHER HOWE. CHINA AND THE GLOBAL ENERGY CRISIS: DEVELOPMENT AND PROSPECTS FOR CHINA'S OIL AND NATURAL GAS (Edward Elgar Publishing, 2007).

4. ENVIRONMENTAL CONSIDERATIONS: WATER RESOURCE MANAGEMENT

Shale gas is a clear and efficient burning fuel with the potential to lower carbon emissions. Nevertheless, risks remain and shale gas' greater role in the world overall energy mix has met with fierce opposition due to environmental concerns over the hydraulic fracturing technology and its potential to cause environmental harm in the shale gas context[41] with its shallower deposits, greater permeability and more superficial formations.[42] Fracking involves drilling a well bore into the reservoir rock formation and then forcing water, sand and chemicals into the well at high pressure 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 seam and tight sand deposits. These considerations imply that the extent to which shale gas will be a larger element of the energy mix will depend on the environmental protection versus economic growth trade-off. Some states in the U.S. and some EU countries, such as France, have already banned or imposed moratoria on hydraulic fracturing due to environmental concerns,[43] trying 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 satisfying growing domestic energy demands as well as create new jobs that full-scale production would generate in particular for low-skilled workers.[44] However, it is one thing finding

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[41] The focus of this study on the environmental aspects related to shale gas exploration and extraction should not make us oblivious of the other issues that may impact on the development of global unconventional gas resources: fiscal conditions, landowner acceptance, interference from local authorities, pipeline and infrastructure issues, availability of technology, equipment and skilled labor force, and gas players' experience. 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(2) HOUSTON JOURNAL OF INTERNATIONAL LAW 369 (2011).

[42] Moratoria represents a the precautionary measure par excellence. ARIE TROUWBORST, PRECAUTIONARY RIGHTS AND DUTIES OF STATES 129 (Martinus Nijhoff Publishers, Leiden, 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 TEXAS WESLEYAN LAW REVIEW 1, 3 (2011); Thomas Swartz, *Hydraulic Fracturing: Risks and Risk Management*, 26 NATURAL RESOURCES AND ENVIRONMENT 30, 30 (2011).

[43] The French Senate approved a ban on 'fracking' in June 2011, as a result of the extensive public protests. However, fracking is still permitted for scientific testing. See Ruven Fleming, *Shale Gas-a Comparison of European Moratoria*, 1 EUROPEAN ENERGY AND ENVIRONMENTAL LAW REVIEW 12-32 (2013).

[44] In the U.S., the shale gas industry has created 600,000 new jobs. Secretary of Energy Advisory Board ("The Deutch Committee"), Shale Gas Subcommittee 90 Day Report, August 18, 2011, at 1, 5. See also Thomas C. Kinnaman *The*

shale gas, and another generating commercially viable production from it, bearing in mind the relevant geological factors, infrastructure challenges and environmental hazards.

It is crucial to assess how harmful the fracking process might be to the environment.[45] Principal concerns include groundwater contamination with fracking chemicals,[46] gasification,[47] water usage risks, surface water and soil risks spills and blow-outs. Environmentalist argue that although hydraulic fracturing is believed to be less water intensive than nuclear and coal, it is unlikely that it will replace either energy source. Rather, shale gas development carries the danger to create 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.[48] In shale gas rich Sichuan Basin, this is a primary concerns due to the province's agricultural legacy which furnishes the country with roughly 7 percent of China's rice, wheat, and other grains. Moreover, 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. Regulations should also consider the possibility of establishing a closed-loop system of energy production, using mine drainage water from coal production (after having neutralized and removes heavy metals) thus integrating industrial ecology practices into the fracking process. However, this practice should only

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Economic Impact of Shale Gas Extraction: A Review of Existing Studies 70(7) ECOLOGICAL ECONOMICS 1243-1249 (2011).

[45] On the risks related to shale gas development, see generally MARK ZOBACK, SAYA KITASEI, & BRAD COPITHORNE, ADDRESSING THE ENVIRONMENTAL RISKS FROM SHALE GAS DEVELOPMENT (Worldwatch Institute, 2010); Elizabeth Burleson, *Cooperative Federalism and Hydraulic Fracturing: A Human Right to a Clean Environment*, 22 CORNELL JOURNAL OF LAW & PUBLIC POLICY 289 (2012). On the potential health hazards, see Michelle Bamberger& Robert E. Oswald, *Impacts of Gas Drilling on Human and Animal Health* 22(1) NEW SOLUTIONS, A JOURNAL OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH POLICY 57–77 (2012).

[46] Currently China does not have a regulatory framework aiming at ensuring that wastewater injection into underground wells will not endanger groundwater. These regulations would ensure that wastewater injection into underground wells, including injection of hazardous wastewater produced from hydraulic fracturing, does not menace local water supplies. Lan Nan, *Legal Tools for Groundwater Protection: Insights from International Experience* 8 CHINA JOURNAL OF NATURAL RESOURCES ECONOMICS 33-43 (2011) (in Chinese).

[47] 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 seismic activity in the United Kingdom, though these claims are largely uncertain at this point and being investigated. See KPMG Global Energy Institute, *supra* note 22.

[48] Fracturing technology uses high water volumes (11-26 million liters per well), and requires wastewater treatment, safe disposal or reuse.

be implemented after groundwater regulations are strengthened, and after China has gained substantial experience in minimizing pollution from fracturing operations and can ensure proper disposal of the heavy metal waste products from treating these industrial water sources.[49]

Water is an urgent issue for China as its per capita availability of drinking water is very low and water resources are not well distributed through the country.[50] Diverging water supplies from the agriculture to shale gas production could be catastrophic, in particular if the contaminated water also pollutes the 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 unsustainably raise costs and the environmental impact. Furthermore, climate change and China's rapid economic development has led to an increase in industrial and agricultural water consumption, while areas of desertification are expanding, deteriorating the ecological environment which is already over-exploited. [51]

China's poor law enforcement has undermined the efficacy of past efforts. In particular China features a highly fragmented water resource management system. Horizontally several institutions are involved at every level of government. At the central level, the National People's Congress and the 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:[52] the Ministry of water resources, which is a leading agency for integrated water resource management, water resource protection planning, water function zoning, monitoring water

[49] 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 Department of Environmental Protection, *DEP Effort Encourages Oil and Gas Industry to Use Mine Drainage Water*, Nov. 18, 2011, available at: http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=19161&typeid=1.

[50] 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 ed., Ashgate Publishing, forthcoming).

[51] On desertification and water management in China, see CI LONGJUN, DESERTIFICATION AND ITS CONTROL IN CHINA (Springer, 2010).

[52] A common expression to describe the current system is that "nine dragons" manage the water. Wang Xinbo, *Water Governance in China: The Failure of a Top-Down Approach*, in THE WATER REVOLUTION: PRACTICAL SOLUTIONS TO WATER SCARCITY (Barun Mitra, Kendra Okonski & Mohit Satyanand eds, International Policy, 2006); Yan Feng, He Daming, & Beth Kinne, *Water resources administration institution in China* 8(4) WATER POLICY 291-301 (2006).

quantity and quality in rivers and lakes; issues water resource extraction permits, proposes water pricing policy; the Ministry of Environmental Protection, 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 Ministry of Land and Resources; the State Forest Administration; the Ministry of Transportation State Oceanic Administration National Development and Reform Commission; and the Ministry of Finance.[53] This unwieldy regime carries the risks of creating overlaps and frictions in responsibility, as the lines of demarcation between institutional jurisdictions and competences are not always clear. Even the responsibility for water pollution prevention and control, which should represent a fundamental step in the shale gas extraction process, is distributed to different governmental bodies. Moreover, these institutions do not cooperate, further increasing the administrative cost of coordination and undermining the overall effectiveness. Vertically, the water management regime features a similar fragmentation and it relies on unclear administrative boundaries linked to different levels of government. Finally, the political frictions and information asymmetry between central and local governments make a more meaningful cohesive action unattainable. 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 the water management but the 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.[54]

It remains to be see what the implications will be for the shale gas industry expansion in China, whether this fragmentation will further hamper its development or these challenges will be adequately met by a more integrated system inspired, for instance, to the water resource management systems of France or the United Kingdom.[55] Given the fact that in China levels of

[53] See JIAN XIE, ADDRESSING CHINA'S WATER SCARCITY (The World Bank, 2009) at 30; Jiang Yong, *China's water scarcity* 90(11) JOURNAL OF ENVIRONMENTAL MANAGEMENT 3185-3196 (2009).

[54] Bo Kong, *Governing China's Energy in the Context of Global Governance*, 2 GLOBAL POLICY, SPECIAL ISSUE 51–65 (2011).

[55] Those water resource management systems, specifically aim at ensuring the security of water supplies, protecting the ecological resources of the water environment, and improving the efficiency of the local level 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.

pollution from industry and agriculture are dangerously high, shale gas should be developed and extracted relying on a regulatory and institutional framework capable to reduce any related environmental hazards, sticking a balance between energy security benefits and environmental costs, in order to universally guarantee the right to water.

The recognition of the right to water has been debated in a number of international law *fora*[56] and in 2010 China voted in favor of a UN General Assembly resolution recognizing the right to water as a human right.[57] Resolution 64/292 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 it is generally regarded as a soft law legal instrument. The vote in favor of the UN General Assembly resolution is an important first step but China should pursue a 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 State to adopt, *inter alia*, effective legislation to restrain third parties from polluting water resources.[58] 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 first step in the right direction,[59] but it should be accompanied by

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[56] The right to water is a crucial element in the work of the Human Rights Council, the United Nations General Assembly as well as of many scholars and NGOs. In September 2020, a resolution adopted by consensus by the Human Rights Council affirmed that the right to water and sanitation is recognized in existing international law. See Human Rights Council resolution, Human Rights and Access to Safe Drinking water and sanitation, Doc. A/HRC/15/L.14, Sept 30, 2010.

[57] General assembly Resolution, The Human Right to Water and sanitation, Doc. A/RES/64/292, Aug. 3, 2010.

[58] Jade Harsha , *Conflicts and Dilemma of Human Right to Water* 100(12) CURRENT SCIENCE 1178, 1778 (2011).

[59] 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 that "*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, unreclaimed 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 anaimals 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, the Law of the People's Republic of China on Prevention and Control of Water Pollution the Water, see *infra* note 64. William C. Jones, *The Constitution of the People's Republic of China*, 63 WASHINGTON UNIVERSITY LAW QUARTERLY 707 (1985), available at: http://digitalcommons.law.wustl.edu/lawreview/vol63/iss4/4

monitoring and enforcement measures. In this vein, Peter Gleick points out that while debates about the adequacy of Chinese environmental standards continue, there is little dispute that enforcement of existing water-quality and monitoring laws has been grossly inadequate.[60]

Another issue has triggered widespread public concerns: hydraulic fracturing is also supposedly responsible for a number of incidences of seismic activity such as minor earthquakes and tremors. These seem to be caused by either the fracking process itself or the injection of fracking wastewater into wells. So far, there has been a more than four-fold increase in earthquakes of magnitude three and greater in central U.S. since 2008, "almost certainly" caused by fracking activities.[61] Similarly, in April and May 2011 shale gas exploratory drilling has been suspended in Lancashire, U.K., following two earthquakes with magnitudes of 1.5 and 2.3. A consequent independent scientific report commissioned by the British government indicated that "the earthquake activity was caused by direct fluid injection" during the fracking process".[62] This of course has relevant implications for local residential and infrastructure damage. Seismic activity could also impacts on well's integrity and cause further underground water contamination, as it could create leakages and new fractures, besides deforming well casings. Moreover, Sichuan province, where most of the Chinese shale gas is located, is an earthquake extremely prone region (The 2008 Great Sichuan Earthquake killed 69,195 people, with over 18,300 missing).

5. CHINESE REGULATORY FRAMEWORK

The current Chinese regulatory framework lacks cohesive and satisfactory provisions regarding shale gas extraction and its related environmental concerns. What appears to emerge is a generalized absence of cohesiveness of the energy resources system which is characterized by institutional fragmentation and conflicts of interests among a plethora of relevant entities and actors. The Chinese legal system features a tripartite structure: the National People's Committee passes Laws;

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[60] Peter Gleick, *China and Water*, in THE WORLD'S WATER 2008-2009: THE BIENNAL REPORT ON FRESHWATER RESOURCES 432 (Peter H. Gleick, Heather Cooley & Mari Morikawa eds, 2008).

[61] Ajay Makan, *Fracking Water Linked to Earthquakes* , THE FINANCIAL TIMES, April 14, 2012 , available at http://www.ft.com/intl/cms/s/0/e268a268-84f6-11e1-a3c5-00144feab49a.html#axzz2gMxH4mz3.

[62] Nevertheless, the very same report concluded that operators could resume fracking operations, as long as they were effectively regulated.

the State Council passes Regulations; various ministries create Rules, and departments within the ministries create other normative legal documents. In the context of shale gas production, the Ministry of Environmental Protection 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, regulated and enforced through provincial and municipal-level branches of the Ministry of Environmental Protection.[63]

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 not passed legislation or provided any guidance for shale gas exploration, market application, and strategic planning. Despite this, several existing laws, if broadly interpreted, might be applied, although they are neither exclusively concerned nor purposely drafted to deal with shale gas. In particular, the most pertinent law *vis-à-vis* shale gas production and its potential environmental perils is the Water Pollution Prevention and Control Law (WPPCL),[64] which sets forth central and local water standards to which local governments have to adapt their regulations within a "cooperative federalism" framework.[65] This legal tool prescribes a number of measures aiming at protecting drinking water[66] and forbidding the construction of drainage outlets in specific areas. Article 38 of the Water Law prescribes that "*protective measures shall be taken. . . while constructing underground engineering facilities or carrying out underground prospecting, mining, and other underground activities*." The expression "*other underground activities*" certainly includes the fracturing process. The Water Law further prevents

[63] ALBERT CHEN, AN INTRODUCTION TO THE LEGAL SYSTEM OF THE PEOPLE'S REPUBLIC OF CHINA (Hong Kong: LexisNexis/Butterworths, 2004).

[64] Law of the People's Republic of China on Prevention and Control of Water Pollution or WPPCL (adopted by Standing Committee of the Sixth National People's Congress 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 ACADEMY OF ENVIRONMENTAL LAW E-JOURNAL 69-74 (2012), available at SSRN: http://ssrn.com/abstract=2040619.

[65] Elizabeth Burleson, *Cooperative Federalism and Hydraulic Fracturing: A Human Right to a Clean Environment* CORNELL 22 JOURNAL OF LAW AND PUBLIC POLICY 289 (2013), available at SSRN: http://ssrn.com/abstract=2007234 or http://dx.doi.org/10.2139/ssrn.2007234.

[66] Law of the People's Republic of China on Prevention and Control of Water Pollution, *supra* note 64, Article 56.

the discharge of a number of chemicals usually used in American fracturing fluids,[67] while allowed pollutant discharges are capped at fixed amounts".[68] Although the WPPCL constitutes a fundamental tool in relation to the issues analyzed in this paper, its coverage is still limited in the sense that while it requires that the state establishes and improves compensation mechanism for ecological protection of the water environment in drinking water sources areas and reservoirs by instruments such as payment of transfers, there are not supporting laws and regulations. Furthermore, the WPPCL contains some ambiguous provisions and, for instance, it lacks any definition of the authority of the local governments, creating a vacuum that negatively affects the effectiveness of the regulatory framework. The Law permits the governments of provinces, autonomous regions, and municipalities to establish their own standards for items not set by a central body and it includes strong punitive measures to be imposed upon violators who can be fined and ordered to remediate the damage they have caused. In particular, in the amended WPPCL promulgated in February 2008 and effective on June 1 2008, stricter penalties against non compliants have been added to enhance law enforcement. Nevertheless, without detailed guidelines for implementing the law, effective enforcement of those stricter penalties remains a question.

Other relevant legal instruments are the Mineral Resources Law[69] and the Regulations of the Peoples Republic of China on Sino-foreign Cooperation in the Exploitation of Continental Petroleum Resources.[70] The former outlines a unified regional registration regime for the exploration of mineral resources, and it is thus applicable to shale gas exploitation.[71] 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

[67] Such as "*any oil, acid, or alkaline solutions or highly toxic liquid waste*"[67] or "*any highly toxic soluble waste residue containing mercury, cadmium, arsenic, chromium, lead, cyanide, etc*." Id. article 29 and 33.

[68] Law of the People's Republic of China on Prevention and Control of Water Pollution, *supra* note 64, Article 18.

[69] Mineral Resources Law of the People's Republic of China (adopted Sixth National People's Congress on March 19, 1986, amended August 29, 1996).

[70] Regulations of the People's Republic of China on 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, Sep. 23, 2001, adopted September 18, 2007).

[71] Mineral Resources Law of the People's Republic of China (adopted Sixth National People's Congress on March 19, 1986, amended August 29, 1996).

approval are quite vague and the law does not specifically define them.[72] On the other side, the Regulations of the Peoples Republic of China on Sino-foreign Cooperation in the Exploitation of Continental Petroleum Resources[73] targets the types of partnerships currently spreading in the exploration and production of unconventional gas.

Carrying out an assessment of the rationale of the traditional Chinese environmental laws,[74] what appears to emerge is that they focus on the development and use of natural resources by humans rather than the relationship between humans and nature,[75] whose ethical basis is to be found in the deep-rooted concept of "harmonious nature".[76] These laws do not emphasize the prevention of

[72] 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.*

[73] Regulations of the People's Republic of China on 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, Sep. 23, 2001, adopted September 18, 2007).

[74] Such as The Prevention and Control Atmospheric Pollution Act, The Prevention and Control of Water Pollution Act, The Prevention and Control of Solid Wastes Act, and The Prevention and Control of Prevention from Environmental Noise Act, Prevention and Control of Radioactive Pollution Act. The Prevention and Control of Atmospheric Pollution Act, (promulgated by the Standing Committee of the Ninth Nat'l People's Congress, Apr. 29, 2000, effective Sept. 1, 2000) (P.R.C.) http://www.fdi.gov.cn/resupload/epdf/e0l407.pdf; The Prevention and Control of Water Pollution Act, (promulgated by the Standing Committee of the Sixth Nat'l People's Congress, May 11, 1984, amended on May 15, 1996) (P.R.C.) available at http://www.lehmanlaw.com/lib/library/Laws-regulations/environment/water pollution.htm; The Prevention and Control of Solid Waste Act; The Prevention and Control of Environmental Noise Pollution Act, (promulgated by the Standing Committee of the Eighth Nat'l People's Congress, Oct. 29, 1996, effective on Mar. 1, 1997) http://www.lehmanlaw.com/libflibrary/Laws-regulations/environment/noise-pollution.htm; Prevention and Control of Radioactive Pollution Act, (promulgated by the Standing Committee of the Tenth Nat'l People's Congress, June 28, 2003, effective Oct. 1, 2003)(P.R.C.), available at http://english.gov.cn/laws/2005-09/06/content_29737.htm. See Mingde Cao, *Fundamental Principles of Ecological Law***,** 39 WUHAN UNIVERSITY INTERNATIONAL LAW REVIEW 2002.

[75] 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 International Law Review 253 (2006), available at: http://digitalcommons.pace.edu/pilr/vol18/iss1/9.

[76] Mingde Cao remarks that the concept of "harmonious nature" has a deep cultural root in China's traditional culture and it should be inherited and applied to today's environmental challenges. In that respect, Confucianism developed the principles of "the nature and human being understand each other", and of "nature and human being combined into one." Regarding the relationship between humans and the nature, Taoism preached noninterference and adaptation with the course of natural events. In the same vein Buddhism, advocated the right to exist of the natural life forms other than human. Mingde Cao & Yi-xiang Xu, *The Codification of China's Civil law and Environmental Protection* 4 MODERN LAW SCIENCE 13 (2003). See also Paolo Davide 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

environmental pollutions, rather focusing on remediation and passive reactions and eventually carrying the danger of disharmony and frictions 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,[77] rather than stressing economic growth, which is nevertheless considered a legislative priority by the National Standing Committee of the People's Congress. That said, recent Chinese environmental laws are substantially different from the earlier legal instruments and foster recycling economy and regulate clean processes of production,[78] focusing in minimizing pollution from the very beginning through all the production process. In the context of shale gas environmental hazards, two legal instruments come into play: the 2003 Law of People's Republic of China on the Promotion of Clean Production[79] and the 2002 Law of People's Republic of China on Environment Impact Assessment (EIA).[80] 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*"

Political System)", in IDENTITÀ EUROPEA E POLITICHE MIGRATORIE 193-226 (Giovanni BOMBELLI e Bruno MONTANARI eds,, Vita e Pensiero, 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., Ashgate Publishing, forthcoming).

[77] On Feb. 19, 2005, Chinese President Hu Jintao stressed the importance of developing the capacity of creating a "harmonious socialist society", i.e. a society based on democracy and rule of law, fairness and justice, honesty and friendliness, full of vigor, and an harmonious relationship between humans and nature. See Hu Jintao, *Building a Harmonious Society Important Task for CPC*, PEOPLE'S DAILY ONLINE, Feb. 21, 2005. *See* Paolo Davide Farah, *Five Years of China's WTO Membership. EU and US Perspectives about China's Compliance with Transparency Commitments and the Transitional Review Mechanism*, 33 (3) LEGAL ISSUES OF ECONOMIC INTEGRATION, pp. 263-304 (2006). 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 contrast with energy security and economic development.

[78] "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., the production is organized in accordance with ecological principles, and the raw materials are recycled in a closed cycle.

[79] Law of the People's Republic of China on the Promotion of Clean Production (promulgated by China National People's Congress June 29, 2002, effective Jan. 1, 2003) .

[80] 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 VERMONT JOURNAL OF ENVIRONMENTAL LAW 278 (2006-2007). Adopted on October 2002, the EIA became effective on September 1, 2003.

through respect of international standards and best practices. On the other hand, the 2002 Law on Environment Impact Assessment (EIA) 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[81] and the principle of environmental law of "pollution prevention first".[82]

In light of the aforesaid, China undoubtedly has a number of laws that could 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 *vis-à-vis* shale gas production, shaping an inconsistent and fragmented combination of regulations addressing other non-traditional extractive industries and government's directives on extraction. In particular, regulations developed by the Ministry of Environmental protection deal with issues related to emissions standards, surface draining systems, and restriction to gasses emission in the environment. Regulations developed by the Ministry of Land and Resources 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 portion of their output with the government besides paying corporate taxes on profits. Finally, land rights and control of shale acreage are also tackled by regulation issued by the Ministry of Land and Resources and not directly by national oil companies.

6. FUTURE REGULATIONS: INCENTIVES, SUBSIDIES AND FISCAL EXEMPTIONS? REFLECTING COALBED METHANE POLICIES.

[81] 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 INTERNATIONAL AND COMPARATIVE LAW REVIEW 387, 387-389 (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, Carl Folke, & Gary P. Kofinas, *A Framework for Understanding Change*, in PRINCIPLES OF ECOSYSTEM STEWARDSHIP: RESILIENCE-BASED NATURAL RESOURCE MANAGEMENT IN A CHANGING WORLD 6 (F. Stuart Chapin, III, Carl Folke, & Gary P. Kofinas eds, Springer, 2009). See also Doug M. Brown, *Market and Exchange in Premodern Economies*, in 2 ENCYCLOPEDIA OF POLITICAL ECONOMY 84-88 (Philip Anthony O'Hara ed, London: Routledge, 2001).

[82] On this principle, see James E. Hickey Jr, & Vern R. Walker, *Refining the Precautionary Principle in International Environmental Law* 14 VIRGINIA ENVIRONMENTAL LAW JOURNAL 423 (1994); and NICOLAS DE SADELEER, ENVIRONMENTAL PRINCIPLES: FROM POLITICAL SLOGANS TO LEGAL RULES (Oxford University Press, 2002).

China has a number of laws that could play a role *vis-à-vis* shale gas production. However, a comprehensive policy on this issue is still to be shaped, as there has not yet been consensus on the best way to proceed, The Chinese government has nevertheless introduced some incentives to foster the development of shale gas. In December 2011, China's State Council approved changing the legal status of shale gas from "natural resource" to an "independent mining resource", meaning that now it is exempted from the restrictive legal regime in effect for the exploration and production of hydrocarbons in China. This change of legal status disentangled shale gas from the oil and gas franchise, which precludes wider social investment from natural gas extraction, whilst giving private capital the opportunity to engage in this process.

Some commentators[83] believe that the Chinese policy on the development and production of shale gas will likely reflect the one adopted for coalbed methane (CBM).[84] This would imply a patchwork of import tax reductions or exemptions for technology imports that are used for shale gas exploration; exemptions of prospecting and mining royalties; and production subsidies. The government is indeed already relying on the policy developed for CBM as a reference for shaping a Chinese shale gas development policy.[85] In particular, it is interesting to analyze the environmental policies defined in the context of CBM and coal-mine methane (CMM), which could inspire new measure applicable to shale gas production. Specifically, the Ministry of Environmental Protection issued the Emission Standard of CBM/CMM in 2008, embracing new coal mines, surface drainage systems, and existing mines and systems. As for foreign cooperation policies, exploration of CBM through foreign companies has to be consistent with domestic regulation on on-shore petroleum resources, in order to guarantee a minimum standard, which would also be advisable in the shale gas sector. Cooperation must be rooted in standard production-sharing contracts (PSC), which represent one of the main forms of international cooperation in the development of oil and gas in China, according to which the foreign investor bears all the costs and risks incurred during the exploration,

[83] See, *infra* note 84, 85.

[84] Coal Bed Methane (CBM): CBM is natural gas that is produced from coal seams, which act as the source and reservoir for the natural gas. Dameng Yu, Yuanjiang Yang, Qi Liu, and Huang Wenhui, *A Review on Studies of Coalbed Methane Reservoirs in China* 1 GEOLOGICAL SCIENCE AND TECHNOLOGY INFORMATION 13 (2001), Qin Yong, *Advances and Reviews on Research of Coalbed Gas Geology in China* 3 GEOLOGICAL JOURNAL OF CHINA UNIVERSITIES 2 (2003).

[85] D.K. Luo, Y.J. Dai, & L.Y. Xia, *Economic Evaluation Based Policy Analysis for Coalbed Methane Industry in China* 36 (1) ENERGY 360-368 (2011).

extraction and production processes. The Chinese leadership should also support the development of technology research and development, as it did in the framework of the National Key Technologies Research and Development Program of 1983, through which the government backed the development of CBM exploration and development technology.[86] In this vein, the development of innovative oil and gas exploration technology is also being bolstered under the auspices of the National Medium and Long-term Science and Technology Development Program (2006–2020).[87]

A specific fiscal policy for energy firms engaging in these sectors should be supported. For example, for all CBM energy companies, value-added taxes are reimbursed after being levied. Similarly, import duties, import-related tax, and value-added taxes are exempted for CBM exploration and development operations, equipment, spare parts, and special tools. Preferential corporate income taxes are also desirable. For instance, the Chinese government has levied corporate income taxes for independent CBM domestic companies at a favored rate of 25 percent starting from 2008. Likewise, domestic energy companies working in cooperation with foreign companies on CBM are granted a preferred corporate income tax policy according to which income tax is exempted in the first two years from the profit-making year, and then levied with a 50 percent reduction in the following three years. This scheme could allow energy companies to successfully cope with the high initial costs of shale gas production in order to spur investments and technology development. Finally, arguing that the marginal cost of China's shale gas production is significantly higher than conventional gas, a subsidizing policy is advisable in order to help enterprises engaging in shale gas development and make shale gas in China commercially viable. This technique has already been adopted for by the Ministry of Finance for energy companies engaged in CBM/CMM extraction within China which are entitled to a financial subsidy of 0.02 CYN per cubic meter from the central government if the gas is employed on site or commercialized for residential use or as a chemical feedstock.

The Chinese government has already offered to shale gas mining enterprises a subsidy of 0.4 CYN per cubic meter from 2012 to 2015, which is twice the subsidy provided for coal bed methane.

[86] Baizhan Li & Runming Yao, *Urbanisation and its Impact on Building Energy Consumption and Efficiency in China*, 34 (9) RENEWABLE ENERGY 1994–1998 (2009).

[87] Shulin Gu et al., *China's System and Vision of Innovation: Analysis of the National Medium- and Long-term Science and Technology Development Plan (2006-2020),* Paper presented in the IV Globelics Conference at Mexico City, September 22-24 2008, available at https://smartech.gatech.edu/jspui/bitstream/1853/36898/1/Shulin_Gu_China_System_and.pdf.

Moreover, according to the revised Foreign Investment Industry Guidance Catalog (which took effect on January 30, 2012), 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. Furthermore, imported equipment and technologies for shale gas exploration and development, that are for self-use and cannot be manufactured in China, are exempted from customs/duties.[88]

7. BETTER ENFORCEMENT OF LAWS THROUGH TRANSPARENCY AND DISCLOSURE OF ENVIRONMENTAL INFORMATION

The breakthrough of shale gas exploration and production in China is undermined by the country's unsatisfactory record of environmental enforcement which jeopardizes the capacity of existing laws to prevent and minimize the downsides of hydraulic fracturing. China relies on a multilevel system of authority based on the 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[89] which are responsible for supervising the implementation of central laws; investigating major pollution events; coordinating and settling trans-boundary environmental disputes; and receiving and coordinating complaints. However, the efficiency of the Government RSCs is weakened by several constraints as the Centers are extremely underfunded, which results in weak governmental enforcement capacity, and they are financed by local governments, causing conflicts of interest, corruption and complicity.[90] 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 the Centers more adequate funding and greater powers.

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[88] Desheng Hu & Shengqing Xu, *Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas* 60 ENERGY POLICY 21, 21-26 (2013).

[89] Scott Moore, *Commentary: Shifting Power in Central-Local Environmental Governance in China: the Regional Supervision Centers*, 11 CHINA ENVIRONMENT SERIES 188 (2010/2011).

[90] *Id.* at 191.

Furthermore, other factors not limited to the area of water pollution control and prevention contribute to determine the current weak law enforcement in China. In particular, the exiting legal instruments lack enforcement mechanisms and procedures, e.g. supervisions, monitoring, reporting and evaluation. The enforcement of environmental laws could be improved through legal instruments that facilitate the access of general public to information and statistics in order to foster a positive feedback mechanism which would exercise a greater pressure on local or central government to enforce existing regulations.[91] These transparency measures have already contributed to fill 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),[92] which fosters and promotes emergency preparedness by asking the local and federal governments to public precise information about the presence of potential chemical risks.[93] Similarly, the EPA's Toxics Release Inventory (TRI)[94] 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, the 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 or rules requiring drilling companies to reveal some, though not all, of the chemicals they use. The US Groundwater Protection Council and US Department of Energy have also developed a web-based national registry (so called FracFocus), which allows the public to access information, on a well by well basis, on chemical constituents used in hydraulic fracturing. Moreover, in some states, such as Texas and Colorado, disclosure on FracFocus is a mandatory legislative requirement.

[91] Ma Jun, *Public Disclosure in China: Fighting Pollution with Open Information*, Chian Dialogue, Dec. 13, 2010, available at https://www.chinadialogue.net/article/show/single/en/4001-The-power-of-public-disclosure.

[92] Emergency Planning and Community Right-to-know Act (EPCRA) Code of Federal Regulations, 40 CFR Parts 355, 370, and 372. The Emergency Planning and Community Right-to-Know Act: Section 313 Release and Other Waste Management Reporting Requirements. Environmental Protection Agency publication EPA 260/K-01-001, February 2001.

[93] EPCRA §§ 311–12 (2011).

[94] TRI was established in 1986 by the Emergency Planning and Community Right-to-Know Act (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 EPCRA and section 6607 of PPA. Environmental Protection Agency, Toxic Inventory Release Program, May. 12, 2013, available at http://www.epa.gov/tri/lawsandregs/index.htm

In China, transparency initiatives are growing in order to tackle information shortcomings. The Water Pollution Prevention and Control Act[95] requires the environmental protection administration departments of the local people's governments to periodically disclose pollution quantity control targets.[96] This legal tool also requires environmental protection administration department of the State Council and local governments to "name and shame" local governments[97] who fail to meet their quantity control targets.[98] The first Ministry-level disclosure law is the Measures on Open Environmental Information (for Trial Implementation) which was passed on February 8, 2007 by the Ministry of Environmental Protection in order to foster public participation in fighting pollution.[99] The Measures require companies to timely and accurately disclose their environmental information[100] and promote citizens involvement, in that "citizens, legal persons and other organizations" are allowed to "request environmental protection departments to obtain government environmental information."[101]

Despite the progresses made by Chinese local governments regarding transparency and disclosure of environmental information, relevant differences amongst provinces and regions remain. In particular the 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

[95] See WPPCL *supra* note 14.

[96] *Id.* Article 19.

[97] Even before the Water Law was approved, some laws fostering transparency and public participation had been adopted, such as 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. The Environmental Impact Assessment Law of the People's Republic of China (promulgated Oct. 28, 2002 by the Standing Committee of the National People's Congress, adopted September 1, 2003).

[98] *Id.*

[99] Measures on Open Environmental Information (for Trial Implementation). Adopted by the State Environmental Protection Administration of China on February 8, 2007; Effective May 1, 2008.

[100] Article 4: "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.*

[101] Article 5. *Id.*

usually impose environmental disclosure requirements for enterprises as mandatory, but merely encourage companies to take their own initiative in providing the relevant information.

Environmental disclosure and transparency directly affect social acceptance, which is a key element for the long-run success of shale gas development, as the previous North American experience shows. It is crucial to develop mutual-trust and mutual-benefit relation between the shale gas industry and relevant local communities. This would minimize the social risk for the developer whilst 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 represent a crucial step towards a safer regulation of shale gas development and a better enforcement of domestic environmental laws.

8. LEARNING FROM THE UNITED STATES?

Although evident differences, similarities between China and the United States in the context of shale gas emerge. Shale gas is a pivotal element for the energy future of both countries, where energy security, energy efficiency and environmental concerns are deeply intertwined. These two countries are net energy importers, hence striving to guarantee greater energy security by boosting domestic resources. Finally, 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. These similarities between the American and Chinese energy system allow drawing some parallels which could be beneficial to the Chinese shale gas industry.[102]

[102] However, the two countries have different geological characteristics. In particular hydraulic fracturing in China is much more geographically challenging than in the U.S., mainly because Chinese shale gas is found in much rougher and deeper terrain than American shale gas, which is usually placed within two to six kilometers deep, whereas in China some key deposits are found six kilometers deep. Hence, the expertise derived from the U.S. shale industry may not be directly functional 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 the U.S. as it is more difficult to be fractured and contains much more non-hydrocarbon gasses, which 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 in which to render the gas more usable. Liu Honglin, *The Drilling and Completion Technology of Shale Gas and It's Status Reservoir Stimulation Technology in Foreign, and Our Adaptive Analysis*, 2009 Senior Symposium of National Oil and Gas Well Engineering Scientific Research Progress and Drilling Engineering Technology, 2009. (in Chinese).

Shale gas development has deeply modified the energy scenario in the United States from a status of shortage to that of plenty and the country, which is the world's biggest energy consumer, may soon become the largest producer of hydrocarbons.[103] As a consequence of the shale gas revolution, North America's natural gas base, now estimated at 3,400 trillion cubic feet, could provide for current levels of consumption for over a hundred years.[104] Shale gas, replacing oil as the principal agent of a new global energetic equilibrium, is already transforming global energy relations and the impact will be more evident when gas exports will begin (the first LNG exports are expected to start around 2017). There are several LNG terminals located in the U.S., originally constructed to import gas, which are now looking to start exporting from the US, 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 U.S. reducing dependence on imported oil and gas supplies and reinforcing domestic manufacturing through lower energy costs.

The U.S. successful shale gas development is due, *inter alia*, to a conducive regulatory environment enrooted in a cooperative federalism framework.[105] In fact, the entire process is regulated by a mixture of states and federal agencies. The formers are responsible for drilling, while the latters have ultimate authority over water treatment and disposal. However, federal government has delegated much of its power to states whose regulations meet or exceed federal minimum standards. Consequentially, while at the federal level, the U.S. has long-established environmental guidelines regulating oil and gas industries, at the state level, regulations concerning the shale industry differ depending on the political inclinations toward the extraction industry. The State of New York, for

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[103] Much of the credit for the technological advancements that allowed the shale gas development is owed to the members of the Mitchell Energy shale gas team, in particular to the late George Mitchell (1919 – 2013), who 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*, THE WALL STREET JOURNAL, Mar. 10, 2010, at A10. See also John Deutch, *The Good News about Gas-The Natural Gas Revolution and Its Consequences*, 90 FOREIGN AFFAIRS 82 (2011); John Deutch, *The US Natural-Gas Boom Will Transform the World*, *THE WALL STREET JOURNAL*, Aug. 14, 2012;

[104] See Yergin, *supra* note 23, at 332.

[105] Francis Gradijan, *State Regulations, Litigation, and Hydraulic Fracturing* 7 ENVIRONMENTAL & ENERGY LAW & POLICY JOURNAL *47* (2012).

example, requires a comprehensive review of the environmental impacts, an application for drilling, and a drilling work plan.[106] In Texas, conversely, drilling permits are usually lax provided that environmental review is required for a proposed project.[107] State regulations, nevertheless, can easily be ignored or enforced depending on the national political guidance. For instance, during the 2000s, shale gas was strongly backed by the "Energy Task Force" directed by, then, Vice-President Dick Cheney. In this context, the Energy Policy Act of 2005[108] was passed, which contained a questionable escape clause that exempted the shale gas industry from the guarantees outlined in the Safe Drinking Water Act[109] and the Clean Air Act.[110] Moreover, under pressure from big oil companies, the U.S. Congress exempted oil and gas production from numerous health and safety laws.[111] Hence, states have primary responsibility for establishing and enforcing safeguards for shale gas production. This regulatory framework is subject to strong controversy as some argue that drilling is a basically unregulated activity. In particular, shale gas can pose significant environmental cross-border issues that cannot be tackled with inconsistent and potentially conflicting legislation at the state level. It is thus likely that the next decade will see much argument about whether federal agencies should have more authority. As for China, a regulatory model fostering cooperation and delegation of responsibilities between provinces and central power would imply other aspects to come into play, such as lack of effective enforcement of environmental standards and information asymmetry.

[106] At the time of writing this article, the State of New York had not yet decided whether to lift a 5-year-old moratorium on hydrofracturing. However, in May 2013 a midlevel court unanimously concluded that the state mining and drilling law does not trump the authority of local governments to control land use. Indeed, more than 50 New York municipalities have already banned shale gas drilling and more than 100 have enacted moratoriums on drilling activities.

[107] On U.S. different States regulation, see generally David H. Getches, *Groundwater Quality Protection: Setting a National Goal for State and Federal Programs*, 65 CHICAGO-KENT LAW REVIEW 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 WILLIAM & MARY ENVIRONMENTAL LAW AND POLICY 31, 56 (2011); Hannah Wiseman, *Fracturing Regulation Applied*, 22 DUKE ENVIRONMENTAL LAW & POLICY FORUM 361 (2012).

[108] The Energy Policy Act of 2005 (P.L. 109-58), signed by President Bush on August 8, 2005.

[109] Safe Drinking Water Act, 42 U.S.C. 300f et seq, 6939b; 15 U.S.C. 1261 et seq.

[110] Clean Air Act , 42 U.S.C. §§ 7401-7671g.

[111] See Wiseman, supra note 107.

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, in particular water sources. Accordingly, the Obama's 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.[112] The rapid development of shale gas in the U.S. has nevertheless stoked environmental controversy and debate. The opportunity of taking the US regulatory framework as a model scheme remains debatable since the US are experiencing difficulties with environmental aspects related to shale gas extraction[113], 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 resolve some of these issues.

a. BARRIERS FOR ENTRY AND UNCERTAINTY OF ENVIRONMENTAL POLICIES

The U.S. success with shale gas is a result of the combination of indulgent federal enforcement, diversified state laws, and the beneficial nature of Cheney's 2005 Energy Policy Act, which attracted developers into the industry. The transparent regulatory regime featuring specific boundaries in federal and state regulations helped investors realize the risks and encouraged them to vigorously invest in new shale basins, which in turn assisted smaller energy firms refine their technology in hydraulic fracking. Consequentially, the shale industries saw a great number of mergers of smaller firms with larger conglomerates, which created further investments, infrastructures, and technological know-how. Conversely, China falls behind due mainly to the very peculiarities of its present regulatory framework concerning shale gas, which is extremely vague and inconsistent and thus produces uncertainty for overseas investors and energy firms.

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[112] In President Barack Obama's March 30, 2011 energy proposal he pointed out that shale gas could play a large role in U.S. energy policy, particularly with the 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."* The White House Office of the Press Secretary, *Remarks by the President on America's Energy Security*, Mar.30, 2011, available at http://www.whitehouse.gov/the-press-office/2011/03/30/remarks-president-americas-energy-security.

[113] *See* Laura C. Reeder, *Creating a Legal Framework for Regulation of Natural Gas Extraction from the Marcellus Shale Formation*, 34 WILLIAM & MARY ENVIRONMENTAL LAW AND POLICY REVIEW 999, 1022 (2010) (describing the complex legal obstacles inherent to shale gas development).

Moreover, the barriers for entry for small and large firms into the American shale gas industry were much lower as individual companies were able to lease or acquire land to explore. They were only required to submit paperwork to the state government. On the contrary, the Chinese central government firmly exerts power on shale gas blocks by organizing auctions or granting exploration rights. This scheme creates various barriers to entry for overseas small and large firms into the domestic shale gas industry[114] as firms to be allowed to auctions had to be either Chinese or Chinese held joint-ventured companies and they needed to have an extremely elevated minimum value.[115] In particular, the approval system for foreign investments in the mineral industry, embracing any underground activities, is subject to both foreign capital and industry access approval mechanisms. The former implies a multi-tiered administrative approval system according to which authorities of different levels exercise different powers over different industrial categories and total investments amount. 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 explorations license and gain the right of exploration and exploitation. As one might expect, such burdensome policy for foreign investments in Chinese mineral industry is far from conducive and favorable 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. Furthermore, investors will likely wait to see what shale gas pricing policies and government support mechanisms are put in place before actually investing in the Chinese shale gas, as uncertainty and regulatory changes might have detrimental effects on them.[116]

[114] In particular, in the first auction, held in June 2011, exclusively 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 2 blocks were eventually awarded. A second auction was organized in October 2012, collecting 152 bids for 20 blocks.

[115] Enterprises are required to invest at least RMB 30,000 ($4,747) 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) in registered capital. Ministry of Land and Resources, *Shale Gas Tender Submission Announcement*, May 17, 2012, available at: http://www.mlr.gov.cn/zwgk/zytz/201205/t20120517_1099388.htm (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 are more difficult to regulate and have less financial and technical ability to adopt best practices. See Enoe et al.,*supra* note 28.

[116] See KPMG Global Energy Institute, *supra* note 22.

The absence of competition in the energy market generates an unfair allocation of resources. In fact in 2001 China has accessed to the World Trade Organization (WTO) and has to increase competitiveness of state-owned energy companies and will restrain national control over energy companies.[117] At the moment, there is no actual competition between the three major Chinese oil companies as they have identical shareholder, i.e. the State-owned Assets Supervision and Administration Commission of the State Council (SASAC). Indeed there is no competition in either energy upstream or downstream sectors as they feature market monopolies and administrative price guides,[118] regardless of the fact that both the Twelfth Five-Year Plan (2011-2015) and the 2012 Energy White Paper call for the introduction of private capital and market mechanisms, which would terminate the current energy monopoly that excites lack of supervision and inefficiency.[119] The only way China could improve its future energy policy is by converting non-market mechanisms to the market mechanism; adopting a modern corporate system for energy companies; and turning the governmental management system into limited supervision from strict controls.[120]

Another strong disincentive to investments in this sector is the uncertainty of environmental policies. Currently, energy companies in China cannot rely on the assurance that shale gas' environmental regulations will be similar to the ones issued for coalbed methane, natural gas, oil, or

[117] As a condition for joining the WTO, China agreed to reduce tariffs on all imported goods, and to open to foreign investors. In return, China has benefitted the Most Favored Nation treatment and reciprocal rights for trade and investment. *See* Paolo Davide Farah, *Five Years of China's WTO Membership. EU and US Perspectives about China's Compliance with Transparency Commitments and the Transitional Review Mechanism*, *supra* note 77. In addition, China agreed on the establishment and enforcement of a stronger intellectual property rights (IPR) regime. Paolo Farah & Elena Cima, *China's Participation in the World Trade Organization: Trade in Goods, Services, Intellectual Property Rights and Trasparency Issues*, in EL COMERCIO CON CHINA. OPORTUNIDADES EMPRESARIALES, INCERTIDUMBRES JURÍDICAS 83-121 (Aurelio Lopez-Tarruella Martinez ed, Tirant le blanch, Valencia, Spain, 2010).

[118] In practice, China National Petroleum Corporation (CNPC), the Sinopec Group and China National Offshore Oil Corporation (CNOOC) possess the absolute majority of the exploration blocks, despites the 1998 Mineral Resources Exploration Block Regulation stipulates that 25,000 units blocks are the maximum features in exploration projects of oil and gas. 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 LAW RESEARCH REPORT] 336 (Law Press China, 2012).

[119] 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 the field of energy, fosters the granting 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 available at http://www.gov.cn/english/official/2012-10/24/content_2250497.htm.

[120] NI JIAN MING, GUOJIA NENGYUAN ANQUAN BAOGAO [NATIONAL ENERGY SECURITY REPORT] 329-330 (People's Publishing House,2005).

coal. Hence, stakeholders cannot conduct a precise risk analysis nor cost-benefit analysis as there is no concrete minimum standard to count on. This uncertainty is in sharp contrast compared with the specific minimum federal regulations concerning emissions, the treatment of water, and the land that U.S. energy companies had to deal with when they started to engage in the shale gas' industry. Those clear criteria allowed them to elaborate accurate risk assessment analysis, even though stakeholders were eventually not required to comply with these standards due to the 2005 Energy Policy Act.[121]

b. FISCAL AND PRICING REGIME

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 usage of resources. Under China's production-sharing contracts, international energy companies must share a relevant percentage of their profits with the government or government-owned companies, besides paying corporate taxes on gains. This creates a deterrent for overseas investors in a high-risk activity such as shale gas exploration and production.[71] Conversely, the U.S. regulatory regime based on royalties requires energy firms to merely pay a portion of project revenues and corporate taxes on gains. The first unconventional gas drilling operations were supported by a federal tax credit provided by the so-called Section 29, a provision contained in the 1980 windfall profits tax bill that played a great role in developing other two forms of unconventional gas, coal bed methane and gas from tight sands.[122] Regardless of the discouraging Chinese fiscal framework, a number of oil multinational companies have been enticed by the potential of Chinese shale gas market (*e.g.* Royal Dutch Shell, BP, ExxonMobil, Chevron, and ConocoPhillips). In 2011, Sinopec inked deals with Eni and ExxonMobil aimed at the investigation of the potential of the Chinese shale plays. In March 2012, Shell became the first company to sign a formal production-sharing agreement with a Chinese entity, the China National Petroleum Corporation (CNPC), which will accommodate Shell with a relevant stake in China's shale gas production.

[121] See the 2005 Energy Policy Act, *supra* note 108.

[122] See Yergin, *supra* note 25, at 328.

As for the Chinese pricing regime for natural gas, it is a mosaic of different market and administered prices, defined according to consumers, wholesale versus retail, onshore versus offshore, and so on.[123] The lack of a national pricing structure is creating uncertainty for potential investors. 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. This is the reason why the price of natural gas is kept at an artificially depressed level which is lower than the international market price. The consequent gap with domestic prices forces Chinese firms to import gas at a loss, significantly reducing natural gas potential relevance. The current government intervention and monopoly energy prices do not reflect the scarcity of resources and 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.[124]

A price and regulatory reform is then much needed. Experimental price mechanisms have already been implemented starting from December 2011 in Guangdong province and in the Guangxi region, where gas prices are no longer kept artificially lower than the market price levels but they are 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. Preferential pricing has already been adopted in other unconventional gas resources which present higher extraction costs as compared to conventional resources; reasonably these regimes could be extended to shale gas production. In particular the government has implemented several preferential policies to support coalbed methane and coalmine methane extraction and commercialization. Other policies include exemption from corporate tax for the first two years of production and a reduction of 50% 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.

Large-scale production of shale gas in the U.S. is already transforming the worldwide dynamics of

[123] For a comparative analysis of the U.S. gas pricing regime, see Boriss Siliverstovs, Guillaume L'Hégaret, Anne Neumann, & Christian von Hirschhausen, *International Market Integration for Natural Gas? A Cointegration Analysis of Prices in Europe, North America and Japan* 27(4) ENERGY ECONOMICS 603–615 (2005).

[124] Twelfth Five Years Plan (2011-2015), available at http://www.britishchamber.cn/content/chinas-twelfth-five-year-plan-2011-2015-full-english-version. 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 ECONOMY] 17 (2004).

gas industry. The rapid growth of this new resources created a Globally, surplus of LNG, whose rapid buildup coincided with the emergence of shale gas as a new supply source.[125] Until 2010 the U.S. were indeed supposed to represent the greatest LNG market due to a projected domestic shortfall. Conversely, shale gas increase may transform the U.S. into LNG exporter, leaving much LNG in search for market that will be only partially absorbed by growing Asia. This over-supply of LNG determined a wider competition among gas suppliers and reduced prices. This is also modifying the economic and political equilibrium stemming from a new, wider geopolitical impact of global gas market which is determining a new gas competition.[126] 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 (GEFC), a gas-exporting countries recurrent forum having its headquarters in Doha, Qatar (which is the main gas supplier to Europe, after Russia). 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.[127] It remains to be seen to what extent the GECF will potentially develop into an OGEC behaving like a cartel. It is not clear how such a cartel would fix the gas rice, either enacting price-fixing mechanisms or imposing production quantitative restrictions. In reality, traded gas is often subject to long-term contracts which 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.[128]

c. PHYSICAL INFRASTRUCTURES

[125] In the US the surplus of domestic gas production is partly due to the mismatches between LNG projects start-ups and the completion of LNG tanker construction combined with the expiry of charter agreement for older tankers as a result of production declines in older projects. See Stevens, *supra* note 24, at 21.

[126] See Yergin, *supra* note 25, at 335.

[127] See Stevens, *supra* note 24, at 23, remarking that this was precisely the mechanism that led to the creation of the OPEC in 1960. *See* also Paolo Davide Farah & Elena Cima, Energy *Trade and the WTO: Implications for Renewable Energy and the OPEC Cartel*", 16 (3) JOURNAL OF INTERNATIONAL ECONOMIC LAW, *supra* note 25.

[128] *Id*., at 22.

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 product from the major gas fields, which could be challenging for smaller exploration and production firms. [129] In particular, there is no integrated national gas grid and most of China's infrastructures were constructed to transport its most important fuel, i.e. coal.[130]

Currently all principal gas transmission lines are owned by the state[131] and a number of new pipelines is needed. Developing transportation and storage facilities is crucial for shale gas expansion, and even though much still need to be done, China plans to build 14,400 miles of new gas pipelines between 2009 and 2015 to reinforce the current 21,000-mile network.[132] In addition, China will need to construct or reinforce infrastructures that can safely dispose of the contaminated material used to fracture the shale rock thus protecting the environment. Energy expert Diana Ngo stresses that these factors are important as they will reduce costs caused by environmental damage occurring in the future. Additionally, these precautionary steps will also help China exponentially

[129] See KPMG Global Energy Institute, *supra* note 22.

[130] 45% of the 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 POLICY 358-368 (2012); Richard Heinberg, & David Fridley, *The End of Cheap Coal* 468.7322 NATURE 367-369 (2010); Wang Bing, *An Imbalanced Development of Coal and Electricity Industries in China*, 35(10) ENERGY POLICY 4959-4968 (2007); Lin Bo-qiang, & Jiang-hua Liu, *Estimating Coal Production Peak and Trends of Coal Imports in China* 38(1) ENERGY POLICY 512-519 (2010).

[131] Currently, CNPC essentially monopolizes pipeline construction and operations in China. It owns and operates 90% of pipelines. Whether CNPC would allow for shale gas transport by the third-party via their pipelines still need to be seen since it has no legal obligation to do so. See Guo-Hua Shi, You-Yin Jing, Song-Ling Wang, & Xu-Tao Zhang, *Development Status of Liquefied Natural Gas Industry in China*, 38 (11) ENERGY POLICY 7457-7465 (2010).

[132] On 23th January, 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 4,200-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 completed1,700-km gas pipeline carries Sichuan Province gas to Hubei, Anhui, Jiangxi, Jiangsu and Zhejiang Provinces, and Shanghai. See McGlade, *supra* note 2.

speed up their well development timeline (for instance, PetroChina took a lengthy period of 11 months to complete the country's first horizontal well).[133]

9. BILATERAL SHALE GAS COOPERATION: THE U.S.-CHINA SHALE GAS RESOURCE INITIATIVE

U.S. President Barack Obama and the former Chinese General Secretary Hu Jintao acknowledged the relevance of fostering cooperation in shale gas development by establishing a 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.[134] The goal of the GSGI is to assist countries seeking to develop their own unconventional gas resources with balancing energy security and environmental concerns.[135] So far, partnerships have been arranged with India, Poland and China. Indeed, 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.[136]

In particular, whether the GSGI can provide a regulatory model to develop unconventional natural gas resources in an environmental sensitive manner remains to be seen. In that respect, the appropriateness of the US legal framework as a model scheme is still debatable, given the problem that shale gas is creating in the US, especially related 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 are still struggling to

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

[134] 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*, Center for American Progress October 2011, available at http://www.americanprogress.org/issues/2011/10/pdf/china_fracking.pdf

[135] David L. Goldwyn, *Briefing,* Global Shale Gas Initiative Conference, August 24, 2010, *available at* http://www.state.gov/s/ciea/rmk/146249.htm.

[136] See KPMG Global Energy Institute, *supra* note 22.

design the most adequate domestic regulatory framework for safeguards. Environmental protection is not the priority for either sides 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 aim at exchanging assessment and extraction technology for Chinese commercial market access. On the other side, China strives for transferring technology from the United States which often implies intellectual property rights' concerns.[137]

Almost all fracking technology and experience is owned by U.S. companies and China needs to leverage them in order to develop its own shale gas services and industries. To this end, Chinese oil companies have already started investing into the U.S. shale market. Namely, China National Offshore Oil Corporation (CNOOC) has joined with Chesapeake Energy on production ventures and Sinopec partnered with Devon Energy in a similar deal. These agreements were minority interests in actual gas production and constituted investments to export fracking know-how and technologies through participation to the exploration and production team.[138] However, the way China will overcome the technology and experience barriers is still open to debate. Some commentators point out that as China's ultimate goal is to achieve and maintain energy security by developing its domestic natural resources, it cannot bid on U.S. technology and expertise. Accordingly, China will keep on investing in major foreign energy companies (as it happened with Chesapeake Energy and Devon Energy), and then it will import early models of hydraulic fracturing in order to develop its own domestic model of fracking technology by reverse engineering the technology.[139]

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[137] *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, available at: http://www.cheminfo.gov.cn/ZXZX/page_info.aspx?id=276022&Tname=hgyw&c=10.

[138] Chesapeake Energy concluded a deal that transferred 33% of its license rights in the U.S. 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 U.S. as Chinese firms bid to take possession of the necessary technology and expertise to hasten their own shale gas revolution. Hinckley remarks that "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 on not just the service and technology, but on the cost of production here in the U.S." Elias Hinckley, *The Road to Chinese Shale Gas Goes Through the U.S.*, available at http://www.energytrendsinsider.com/2012/12/12/the-road-to-chinese-shale-gas-goes-through-the-u-s/

[139] Diana Ngo notes that historically this procedure has been done by the Chinese in the nuclear reactor technology field, where China brought in models from U.S.'s Westinghouse and France's Areva nuclear reactor technologies. Through these partnerships, China was able to reverse engineer and create their own versions of nuclear reactors (albeit less efficient) that are now being sold to developing countries. See Ngo, *supra* note 133.

U.S. companies have a strong interest in supporting bilateral environmental protection efforts as a shale gas related environmental accident in China would affect not only Chinese economy, but it would also augment opposition to fracking technology in the United States.[140] Moreover, if China does not comply with best practices in capturing greenhouse gases, shale gas development will accrue 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 the 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 a safe and secure exploitation of its shale gas resources.

10. FUTURE VIABILITY OF SHALE GAS PRODUCTION IN CHINA

Given its abundance and capacity of burning cleaner than coal and oil, greatly expanded shale gas use in China seems likely, especially in electricity generation. Despite this optimistic and encouraging scenario, several risks could undermine its future viability. Firstly, companies engaging on shale gas production in China must take into account the huge financial risks of starting a venture in which it can take years before investments begin to generate returns. Furthermore, the limited availability of infrastructure would push costs even higher. In particular, the viability of shale gas is threatened by the uncertainty regarding if and when natural gas price will raise higher due to the end of current oversupply.

Secondly, price uncertainty makes the management of costs and financing risks hard. As energy companies engage in shale gas production, they need to keep a close eye on their procurement costs and invest in productivity, technological and capital improvements. Shale formation wells require

[140] As it 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(1) ENVIRONMENTAL SCIENCE & POLICY *1-3* (2012); Howard L. Hall, *Fukushima Daiichi: Implications for Carbon- free Energy, Nuclear Nonproliferation, and Community Resilience* 7(3) INTEGRATED ENVIRONMENTAL ASSESSMENT AND MANAGEMENT 406-408 (2011). On Germany's nuclear energy phaseout see Jahn Detlef & Sebastian Korolczuk, *German Exceptionalism: the End of Nuclear Energy in Germany!* 21(1) ENVIRONMENTAL POLITICS 159-164 (2012).

sophisticated drilling and completion techniques, whose cost per well can be 3 times or more than the cost of conventional wells. The estimate of typical costs for American shale formations, which are less challenging compared to Chinese's, is $4.5 million for drilling and $4.5 million for completion – a total of $9 million per well.[141] Tax costs need to be streamlined, encompassing complex indirect tax and transfer pricing obligations and climbing fuel and resource extraction taxes. Finally, other costs will be linked to the need to satisfy new greenhouse gas reporting and verification requirements. Energy companies engaging in Chinese shale gas market must thus carefully manage their cash flow, define future financing and funding opportunities and evaluate their liquidity risk. In this context it is crucial to carry out precise economic modeling to assess the hazards connected to potential shifts in demand, pricing, costs returns on capital and other crucial performance indicators.

Thirdly, environmental and sustainability concerns are perceived as the biggest challenge facing shale gas development as negative public opinion about the environmental safety of the hydraulic fracturing process could undermine the development of this industry, particularly where the process is used in populated areas. Actually the fracking process has already been banned in some European countries[142] and in some parts of the United States. In the U.K. a parliamentary committee approved this technique of extraction with due precautions after finding no evidence that the process

[141] Eric Penner, *The Truth is Out There – Shale Production Economics – Part 2 – Drilling & Completion Costs*, Aug. 08, 2013, available at http://www.rbnenergy.com/the-truth-is-out-there-shale-production-economics-part-2-drilling-completion-costs.

[142] In Europe, Individual member states are responsible and competent for determining their energy strategy and, as in the US, various responses have been given. France, Bulgaria and the region of Cantabria in the North of Spain have already banned it. Romania, Ireland, the Czech Republic, Denmark and North-Rhine Westphalia in Germany have proclaimed moratoria. Although there is currently no specific EU-wide legislative framework for the exploration or exploitation of unconventional gas, shale gas drilling remains subject to more general EU treaties and directives, including Article 191, Treaty on the Functioning of the European Union, which proclaim the centrality of the precautionary principle and the polluter pays principle in the environmental policy-making within the EU. Furthermore, a number of existing directives, such as the Water Framework Directive, the Environmental Impact Assessment Directive, the mining Waste Directive and the REACH directive on chemical safety, have implications for the fracking process although they are neither exclusively concerned nor purposely drafted to tackle the environmental risks of the fracking process. On the division of competence between the EU and Member States, see RICCARDO TREMOLADA, *European Energy Investment Law: Competences Allocation Between the Member States and the EU* (IUSE Working Paper in the framework of the EPSEI FP7 project, forthcoming).On the possibility that the proposed European Union-Canada Comprehensive Economic and Trade Agreement (or CETA) could give energy and extractive companies with an office in Canada new powers to challenge through investor-state dispute settlement fracking bans, moratoria and environmental standards for fracking sites across the EU (and potentially pave the way for millions of Euros in compensation to be paid to these companies by European taxpayers), see generally Pia Eberhardt et al., *The right to say no: EU–Canada trade agreement threatens fracking bans (*Published by Transnational Institute, Corporate Europe Observatory and the Council of Canadians, May 2013)

imperiled water supplies, provided the operations were carried out with accurate safety procedures.[143] Energy companies operating in China should not be exempted from adopting leading practices to mitigate environmental impact, preserve reputation, and avoid more stringent regulation which could preclude growth of the industry. For example, Shell Oil has tried to diffuse better industry practices and reinforce public perception by issuing its set of "*Global Onshore Tight/Shale Oil and Gas Operating Principles*". These guidelines outline a framework for how Shell and other oil and gas producers should safeguard the environment and the communities in which they drill for and produce natural gas and oil. These principles include: safe well design and operation; protection of groundwater and reduction of water use; emissions reduction and fugitive emissions control; reduction of surface impact; transparency and community engagement. This framework and strategy will allow producers to avoid negative regulatory repercussions for the entire sector.[144]

Finally, as shale gas radically impacts on supply and demand of the world's energy mix and market, new geopolitical factors must be assessed also taking into account that, as far as China is concerned, economic and demographic growth will increase pressure on global energy supplies and thus all fuel sources will have to be exploited.[145] China has historically depended on fuel imports from politically sensitive regions, restraining its foreign policy options.[146] In particular it imported 54, 12 and 5 per cent of its oil, natural gas and coal, respectively in 2010. This predominant dependence on foreign energy poses different risks: disruptions to its imported energy, sustained and extremely

[143] Joint Research Centre of the European Commission (JRC), Institute for Energy and Transport, *Unconventional Gas: Potential Energy Market Impacts in the European Union*, European Commission, (2012); Philippe & Partners, *Final Report on Unconventional Gas in Europe*, Report Prepared for the Directorate-General for Energy in the European Commission (2011).

[144] Those principles have been elaborated in the framework of Shell's "Goal Zero" program, aiming to "operate with no harm to people and no significant incidents". Marvin E. Odum, President of Shell Oil Company stated that the company's "*safety record is built on strict company standards, multiple required safety barriers, rigorous training and competency assurance, adherence to proven operating methods and a culture that requires workers, contractors and visitors to stop any unsafe activity*"; "*At Shell, we believe onshore exploration and production can and must occur in an environmentally responsible manner. anything less is unacceptable*". Shell Oil Company, *Global Onshore Tight/Shale Oil and Gas Operating Principles* (2011), available at http://www.shell.us/aboutshell/shell-businesses/onshore.html.

[145] 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.

[146] In light of the absence of a sustainable supply of conventional fossil energy and excessively rapid growth of demand for energy, the 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 (1) SURVIVAL 179–190 (2006).

volatile energy prices and a clash between china's foreign policy interests and its oversea energy interests.[147] A copious shale gas production can help the country acquire security of energy supply, which could lead to 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.

CONCLUSIONS

China is aware of the role of shale gas as a carbon-friendly energy source in meeting the country's future energy and environmental objectives. The rapid growth of the U.S. shale gas industry has shown that it is a fuel for the future: a relatively low-carbon resources whose flexibility could play a major role as in electric power as an complement to greater reliance on renewable generation. The development of shale gas in China will likely depend on several factors: local reservoir characteristics; technology transfer and innovation, commercial considerations such as infrastructure availability and regulatory environment, applicable rules and laws governing water use.[148] The Chinese government aims at developing resources as domestic as possible and to that purpose it is fostering internal competition among its national oil companies, some of which are already engaged in exploration and development of unconventional gas resources. It thus seems likely that foreign companies' role in China will be restricted to minority holdings in joint ventures with Chinese national oil companies. Overseas companies will be needed for their technical expertise to manage and deploy advanced exploration and development technologies. In this context, foreign companies must thus be aware of the risks related to a joint undertaking in countries that may not apply the same contractual principles and intellectual property rights safeguards. Another issue that must be addressed is environmental degradation, in particular since shale gas exploration and development is a water-intensive process and China's water supply is challenged by several problems: scarcity, rapid urbanization, contamination and pollution. The ability to protect water resources and reduce waste water would hold a key to whether shale gas industry would successfully develop in China.

[147] See Bo Kong, *supra* note 54.

[148] Fan Gao, *Will There Be a Shale Gas Revolution in China by 2012?,* NG 61 Oxford Institute for Energy Studies, April 18, 2012, available at http://www.oxfordenergy.org/2012/04/will-there-be-a-shale-gas-revolution-in-china-by-2020/.

In the light of the aforesaid, some essential elements of the potential Chinese shale gas development have to be pointed out. First, the 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. Indeed, shale gas production in China is in its infancy and a sound regulatory system is required to assure long-term exploitation. An overarching effective unitary regulation would reduce the uncertainty in gas market and foster future investments offering attractive terms to private investors.[149] Second, China needs to tackle the unsatisfactory record of environmental enforcement which jeopardizes the capacity of existing laws to prevent the downsides of hydraulic fracturing. This can be accomplished through adoption of transparency initiatives and mandatory disclosure of environmental information. This would also help reducing the friction between Beijing's concerns over energy security and the opposition by reluctant local communities preoccupied with the environmental costs of shale gas exploration and extraction. Infrastructure development and technology transfer are equally needed, and the previous experience of the U.S. in this sector can be of great help to the 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.[150]

The Chinese national political climate for shale gas appears to be positive as well and in March 2012the first five-year shale gas development plan for the 2011-2015 period was jointly released by the National Development and Reform Commission (NDRC), the Ministry of Finance, the Ministry of Land and Resources and the National Agency of Energy. It calls for the development of a policy framework for the regulation of the country's shale gas sector and it ambitiously estimates that production will reach 6,5 billion cubic feet (bcf) in 2012 and 80 bcf in 2020 from its present production of zero. In this vein, according to the plan, China will develop projects for the "*assessment for shale and confirming the current reserve estimates*"[151] and a National Shale Gas Development Program has been adopted, in which great importance is given to R&D 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

[149] On the contrary, a rigid environmental legislation could inhibit shale gas exploration. This environmental friendly over-regulation, however, does not appear to be likely to develop in China.

[150] See KPMG Global Energy Institute, *supra* note 22.

[151] See Hu & Xu, *supra* note 88.

acquire know-how in shale gas exploration and extraction, it seems probable that the Chinese leadership will keep on encouraging and spurring shale gas commercial exploitation. An actual shale gas market is expected to occur 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, infrastructures development and competition have been announced. However, in late 2012, China went through a transition of political power as Chinese Communist Party chief Xi Jinping formally succeeded Hu Jintao as state president at the 12th National People's Congress (NPC). It remains to be seen what this new politburo of government officials will accomplish for the Chinese shale gas exploration and extraction industry.

Concluding, a successful and adequate shale gas development in China would meet domestic demand and this new resource may grant China stronger bargaining power with gas exporters on price and other matters, narrowing the gap between North American and Asian natural gas prices. The strategic significance of China in the shale gas revolution is undeniable in light of the current rise of energy prices and struggle for reducing harmful emissions in order to contain climate change. It remains to be seen whether the “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 embroiled in the global economy.

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