OVERCOMING BARRIERS TO FRACKING: WHAT SHALE CHINA DO?

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I. INTRODUCTION

China and the United States are the world's two largest energy consumers.[1] China not only bears the burden of being the world's most populated country, but also the world's largest energy consumer.[2] Despite recent economic downturns, China is still a swiftly modernizing economy with a continuously growing middle class able to afford more energy-consuming accoutrements.[3] As a result of this economic growth, China's air

1. Robert Barr, *China Surpasses US as Top Energy Consumer*, NBC NEWS (June 8, 2011, 2:46 PM), http://www.nbcnews.com/id/43327793/ns/business-oil_and_energy/t/china-surpasses-us-top-energy-consumer; Andrew Stocking & Terry Dinan, *China's Growing Energy Demand: Implications for the United States* 1-2 (Cong. Budget Office, Working Paper No. 2015-05), https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/workingpaper/50216-China_1.pdf. In 2012, the United States consumed 95.058 quadrillion BTU of energy, whereas China consumed 105.883 quadrillion BTU. *International Energy Statistics – Total Primary Energy Consumption*, U.S. ENERGY INFO. ADMIN., http://eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=44&pid=44&aid=2 (last visited Feb. 3, 2016). A quadrillion BTU is approximately equal "to the amount of energy in 45 million tons of coal, or 1 trillion cubic feet of natural gas, or 170 million barrels of crude oil." *How Large is a Quadrillion BTU?*, THE MAXWELL SCH. SYRACUSE U. (Mar. 25, 2009), http://wilcoxen.maxwell.insightworks.com/pages/137.html. In 2014, the United States produced 87.389 quadrillion BTU of energy and consumed 98.491 quadrillion BTU. U.S. ENERGY INFO. ADMIN., DOE/EIA-0035, DECEMBER 2015 MONTHLY ENERGY REVIEW 3 tbl1.1 (2015), http://eia.gov/totalenergy/data/monthly/archive/00351512.pdf.

2. U.S. ENERGY INFO. ADMIN., CHINA: OVERVIEW 1 (2015), http://eia.gov/beta/international/analysis_includes/countries_long/China/china.pdf [hereinafter CHINA: OVERVIEW] (stating that China became the world's largest energy consumer in 2011).

3. CHINA: OVERVIEW, *supra* note 2, at 2. In fact, China's economic growth since the 1980s has resulted in a doubling of the country's energy demand. *See e.g.,* INT'L MONETARY FUND, WORLD ECONOMIC OUTLOOK UPDATE: SUBDUED DEMAND, DIMINISHED PROSPECTS (2016), http://www.imf.org/external/pubs/ft/weo/2016/update/01/pdf/0116.pdf; Cynthia W. Cann et al., *China's Road to Sustainable Development: An Overview*, *in* CHINA'S ENVIRONMENT AND THE CHALLENGE OF SUSTAINABLE DEVELOPMENT 3, 8 (Kristen A. Day ed., 2005).

pollution is among the worst in the world.[4] China is also the world's largest coal consumer,[5] and the largest emitter of GHG,[6] sulfur dioxide,[7] and carbon dioxide.[8] In fact, coal constitutes the majority of China's carbon dioxide emissions.[9] The projected uptake in energy demand will spawn a commensurate need for energy regulation to keep pace.[10]

The shale revolution in the United States has stimulated a huge increase in natural gas production and has transformed

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4. Cann et al., *supra* note 3, at 7-8. In 2012, China emitted 8.1 billion metric tons of carbon dioxide. CHINA: OVERVIEW, *supra* note 2, at 2.

5. *See* BRIT. PETRO., BP STATISTICAL REVIEW OF WORLD ENERGY 33 (64th ed. 2015), http://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf (showing that China's share in global coal consumption in 2014 was 50.6%, surpassing all other countries).

6. *See e.g., Beijing Aims to Switch from Coal to Natural Gas*, UNITED PRESS INT'L (Oct. 7, 2013, 3:20 PM), http://upi.com/Business_News/Energy-Resources/2013/10/07/Beijing-aims-to-switch-from-coal-to-natural-gas/UPI-99801381173649/; Richard J. Pierce, Jr., *Natural Gas Fracking Addresses All of Our Major Problems*, 4 GEO. WASH. J. ENERGY & ENVTL. L. 22, 24-25; Justin Worland, *China's Carbon Dioxide Emissions Far Greater Than Previously Acknowledged*, TIME (Nov. 4, 2015), http://time.com/4099460/china-coal-carbon/; Mengpin Ge et al., *6 Graphs Explain the World's Top 10 Emitters*, WORLD RES. INST. (Nov. 25, 2014), http://www.wri.org/blog/2014/11/6-graphs-explain-world%E2%80%99s-top-10-emitters.

7. Alex Wang, *The Role of Law in Environmental Protection in China: Recent Developments*, 8 VT. J. ENVTL. L. 195, 200 (2007).

8. David Biello, *Can Fracking Clean China's Air and Slow Climate Change?*, SCI. AM. (Jan. 27, 2014), http://scientificamerican.com/article/can-fracking-clean-chinas-air-and-slow-climate-change/; Justin Worland, *China's Carbon Dioxide Emissions Far Greater Than Previously Acknowledged*, TIME (Nov. 4, 2015), http://time.com/4099460/china-coal-carbon/; Mengpin Ge et al., *6 Graphs Explain the World's Top 10 Emitters*, WORLD RES. INST. (Nov. 25, 2014), http://www.wri.org/blog/2014/11/6-graphs-explain-world%E2%80%99s-top-10-emitters; *Global Greenhouse Gas Emissions Data*, EPA, https://www3.epa.gov/climatechange/ghgemissions/global.html#four (last updated Feb. 23, 2016); *The Largest Producers of CO2 Emissions Worldwide in 2015, Based on Their Share of Global CO2 Emissions,* STATISTA, http://www.statista.com/statistics/271748/the-largest-emitters-of-co2-in-the-world/ (last visited June 1, 2016).

9. Yingxia Yang & Hengwei Liu, *Impacts of the US Shale Gas Revolution on China's National Energy Security*, 95 OXFORD ENERGY F. 16, 16 (2014).

10. Runming Yao et al., *Energy Policy and Standard for Built Environment in China*, 30 RENEWABLE ENERGY 1973, 1974 (2005) (discussing the importance of legal, administrative, and institutional framework to ensure that energy development in China is sustainable); Xin Qiu & Honglin Li, *Energy Regulation and Legislation in China*, 42 ENVTL. L. REP. 10,678, 10,678 (2012) (describing the energy industry as essential to the independence and security of the country).

world energy trade.[11] Referred to as a "bridge fuel," cleaner than other fossil fuels and capable of replacing hydrocarbons for cleaner energy,[12] shale gas has provided the largest source of growth to the U.S. natural gas supply,[13] and has made the United States the world's largest producer of natural gas.[14] At the turn of the twenty-first century, shale gas production in the United States comprised only 1.6% of the total gas output.[15] By 2007, shale gas production was increasing by fifty percent annually, and by 2012, natural gas produced from shale constituted the largest share of the country's total natural gas production,

11. MATT RIDLEY, THE SHALE GAS SHOCK 5 (2011), http://www.thegwpf.org/images/stories/gwpf-reports/Shale-Gas_4_May_11.pdf.

12. Madelon L. Finkel, *Introduction* to THE HUMAN AND ENVIRONMENTAL IMPACT OF FRACKING: HOW FRACTURING SHALE FOR GAS AFFECTS US AND OUR WORLD, at xviii (Madelon L. Finkel ed., 2015); Paolo Davide Farah & Riccardo Tremolada, *A Comparison Between Shale Gas in China and Unconventional Fuel Development in the United States: Health, Water and Environmental Risks* 2 (gLAWcal Working Paper Series, 2013), http://ssrn.com/abstract=2341738. Chinese law defines shale gas as a clean energy resource, found in rich organic matter, with methane as the main ingredient. Yeyanqi Fazhan Guihua (页岩气发展规划(2011-2015)年) [Shale Gas Development Plan (2011-2015)], CHINA ECONOMIC NET (Feb. 1, 2013, 2:33 PM), http://ce.cn/cysc/ny/zcjd/201302/01/t20130201_21331779.shtml [hereinafter Shale Gas Development Plan] (citing to China's main shale gas policy which later circulated the October of 2012 "Notice Regarding the Strengthening of Shale Gas Exploration, Exploitation, Supervision and Administration" or 国土资源部关于加强页岩气资源勘查开采和监督管理有关工作的通知; DAVID SANDALOW ET AL., MEETING CHINA'S SHALE GAS GOALS 24 (2014), http://energypolicy.columbia.edu/sites/default/files/energy/China%20Shale%20Gas_WORKING%20DRAFT_Sept%2011.pdf.

13. U.S. ENERGY INFO. ADMIN., DOE/EIA-0383, ANNUAL ENERGY OUTLOOK 2014 MT-23 (2014) (noting shale gas as the largest contributor to the 56% increase in total natural gas production from 2012 to 2040) [hereinafter ANNUAL ENERGY OUTLOOK].

14. Archie Fallon & Ji Nin Loh, *Oil and Gas Regulation in the United States: Overview*, PRACTICAL L., http://us.practicallaw.com/9-525-1545 (last visited Feb. 15, 2016); INT'L ENERGY AGENCY, MEDIUM-TERM GAS MARKET REPORT 14 (2012), https://iea.org/publications/freepublications/publication/MTGMR2012_web.pdf [hereinafter IEA REPORT]; Finkel, *supra* note 12, at xv, xvii; INT'L ENERGY AGENCY, KEY WORLD ENERGY STATISTICS 2014, at 13 (2014), http://www.fossilfuelsreview.ed.ac.uk/resources/Evidence%20-%20Climate%20Science/IEA%20-%20Key%20World%20Energy%20Statistics.pdf (stating that production in the U.S. encompasses 19.8% of the world's natural gas).

15. Guanglin Pi et al., *The Status, Obstacles and Policy Recommendations of Shale Gas Development in China*, 7 SUSTAINABILITY 2353, 2354 (2015).

accounting for forty percent of the total.[16] At the same time that the United States was seeing this unprecedented growth in shale gas production, natural gas production from nonshale sources has decreased by twenty-five percent.[17]

Despite this meteoric increase, the growth of the shale gas industry shows no signs of slowing. In fact, the U.S. Energy Information Administration (EIA) predicts that U.S. shale gas production will continue to rise from forty percent of total natural gas production in 2012 to fifty-three percent in 2040.[18] Due to technological innovation and increases in investment, the production of U.S. shale gas is now comparable to production from all offshore wells in the continental United States and is set to "explode" before 2035.[19] However, the shale gas revolution did not happen overnight; rather, it has been "over 20 years in the making," with a plethora of favorable circumstances contributing to its ultimate culmination, including decades of government support.[20]

The success of the U.S. shale gas industry has not gone unnoticed and has created an abundance of social and economic benefits.[21] Fracking has numerous potential benefits; for example, it boosts the U.S. economy and excess supply can be

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16. Christian Downie & Peter Drahos, *Waiting for Godot? China's Search for Shale Gas and Clean Coal Technologies* 5 (RegNet Research, Working Paper No. 2014/59, 2014), http://ssrn.com/abstract=2535681; Tu Tran, *Today in Energy: Shale Gas Provides Largest Share of U.S. Natural Gas Production in 2013*, U.S. ENERGY INFO. ADMIN. (Nov. 25, 2014), http://www.eia.gov/todayinenergy/detail.cfm?id=18951.

17. Tran, *supra* note 16 (showing that the total U.S. gross natural gas production has decreased from 41 Bcf/d in 2007 to 31 Bcf/d in 2013).

18. ANNUAL ENERGY OUTLOOK, *supra* note 13.

19. BRIT. PETRO., BP ENERGY OUTLOOK 2035, at 25 (2015), http://bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2015/bp-energy-outlook-2035-booklet.pdf; Terry Engelder, *Should Fracking Stop? Extracting Gas from Shale Increases the Availability of this Resource, but the Health and Environmental Risks May Be Too High*, 477 NATURE 275, 274 (2011).

20. Paul Stevens, *The 'Shale Gas Revolution': Developments and Changes* 2 (Chathamhouse, Briefing Paper No. EERG BP 2012/04, 2012), http://chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/bp0812_stevens.pdf; John M. Golden & Hannah J. Wiseman, *The Fracking Revolution: Shale Gas as a Case Study in Innovation Policy*, 64 EMORY L.J. 955, 983 (2015).

21. Joseph P. Tomain, *Shale Gas and Clean Energy Policy*, 63 CASE W. RES. L. REV. 1187, 1203 (2013); Stevens, *supra* note 20, at 2; Golden & Wiseman, *supra* note 20, at 983.

exported to Asia.[22] In the United States, fracking has led to more jobs, lower utility bills, and a revival in domestic manufacturing.[23] The U.S. gas industry comprises three million jobs and $358 billion in economic activity.[24]

The increase in U.S. shale production has garnered the attention of other countries seeking to tap into their respective shale gas resources.[25] Nowhere is this more evident than China, which is eager to see its own shale gas become a "game changer."[26] It is unsurprising that China, among others, wants to emulate the U.S. natural gas industry — a desire which some characterize as "revolution envy"[27] — to meet its own domestic energy demand and to (hopefully) provide a similar boost to its economy. [28]

In 2005, China started researching and conducting exploration of its domestic shale gas.[29] Yet by 2013, China produced only a fraction of natural gas from both conventional and unconventional sources as compared to the United States.[30]

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22. Pierce, *supra* note 6, at 23-24.

23. *See id.* at 24 (noting that substituting natural gas for gasoline reduces the costs of transportation and emission of pollutants); Brian Swint & Nidaa Bakhsh, *Shale Revolution Spreads with Record Wells Outside U.S.: Energy*, BLOOMBERG (Nov. 15, 2013, 8:13 AM), http://bloomberg.com/news/2013-11-15/shale-revolution-spreads-with-record-wells-outside-u-s-energy.html (explaining that the shale boom in the U.S has "added jobs, helped revive manufacturing and lowered gas bills").

24. Engelder, *supra* note 19, at 274. Specifically, shale gas production alone is projected to account for 1.6 million U.S. jobs by 2035. Tomain, *supra* note 21, at 1203.

25. Shiwei Yu, *Evaluation of Socioeconomic Impacts on and Risks for Shale Gas Exploration in China*, 6 ENERGY STRATEGY REVS. 30, 35 (2015).

26. The shale gas revolution in the United States has been described as a "game changer" in terms of the impact it has had on the hydrocarbon market and industry. 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 HOUS. J. INT'L L. 369, 371 (2011).

27. Benjamin Haas, *China Misses Output Targets as it Envies U.S. Shale Gas Success*, BLOOMBERG (Feb. 20, 2014), http://bloomberg.com/news/print/2014-02-20/china-misses-output-targets-as-it-envies-u-s-shale-gas-success.html; *see* Yu, *supra* note 25, at 30 (noting China's need to increase its shale gas exploration to satisfy the "[t]remendous energy demands" required to sustain its economic development).

28. For starters, shale gas production alone is projected to account for 1.6 million U.S. jobs by 2035. Tomain, *supra* note 21, at 1203. For a discussion on some of the other benefits resulting from the U.S. shale gas boon, see *id.*; Stevens, *supra* note 20, at 2.

29. Guanglin Pi et al., *supra* note 15, at 2354.

30. In 2013 Chinas produced 117 billion cubic meters (bcm) of natural gas. IEA REPORT, *supra* note 14, at 111. A year later, China produced 4,291 billion cubic feet (bcf) of dry natural gas compared to the U.S. production of 25,728 bcf. *International Energy*

Because of this slow growth, China's shale gas development is not yet profitable.[31] It was perhaps China's recognition of this trend that made the government realize it needed help in getting its own shale gas revolution jump-started. Accordingly, in 2009 the U.S-China Shale Gas Resource Initiative announced that the United States and China would

> use experience gained in the United States to assess China's shale gas potential, promote environmentally sustainable development of shale gas resources, conduct joint technical studies to accelerate development of shale gas resources in China, and promote shale gas investment in China through the U.S.-China Oil and Gas Industry Forum, study tours, and workshops.[32]

The combination of limited conventional reserves and the growing global energy demand has made fracking attractive and economically feasible.[33] By examining a sample of U.S. and Chinese oil and gas laws, policies, and regulations, this Article attempts to juxtapose China's barriers to sustainable shale gas production with those faced in the United States throughout its shale gas revolution. For example, can the U.S. regulatory framework serve as a model for China? China currently has a host of general regulations and laws that are not specifically targeted to regulating the industry but rather are meant to apply to subject matters that are implicated by shale gas activity. One example of this is environmental law. Chinese environmental law consists of a myriad of legislation addressing expansion of comprehensive

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Statistics – Dry Natural Gas Production, U.S. ENERGY INFO. ADMIN., http://eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=3&pid=26&aid=1 (last visited Feb. 4, 2016).

31. Jiehui Yuan et al., *Policy Recommendations to Promote Shale Gas Development in China Based on a Technical and Economic Evaluation*, 85 ENERGY 194, 195 (2015).

32. Joint Statement by the United States of America and the Republic of China on Clean Energy, 927 DAILY COMP. PRES. DOC. (Nov. 17, 2009).

33. *See* Pascal Peduzzi & Ruth Harding, *Gas Fracking: Can We Safely Squeeze the Rocks?*, UNEP GLOBAL ENVTL. ALERT SERV., Nov. 2012, at 1, 1-2, http://www.unep.org/pdf/UNEP-GEAS_NOV_2012.pdf ("[A]s conventional reserves are depleted . . . and demand for energy rises, there is increasing pressure to exploit unconventional energy sources . . . ."); Yuan Chang et al., *Shale-to-Well Energy Use and Air Pollutant Emissions of Shale Gas Production in China*, 125 APPLIED ENERGY 147, 147 (2014) ("Recent advances in drilling and extraction technologies have made it technically and economically feasible to access vast deposits of natural gas from shale formations.").

environmental protection, special litigation for pollution prevention, natural resource protection, and the ratification of international treaties focusing on environmental protection.[34] Can China overcome these hurdles in order to achieve its shale gas revolution dreams? The purpose of this Article is to contribute to the growing body of scholarly writing in the international oil and gas field by contrasting certain features of the Chinese industry, which heretofore was comparably undeveloped, with that of the U.S. industry.

This Article will also examine key shale gas development issues, such as geology, infrastructure, and technology,[35] which may make it unlikely that China will see "meaningful production" until the 2020s.[36] Although the combination of political, technical, regulatory, geological, and environmental factors may limit China's shale gas market growth and make the future of its shale gas development "murky,"[37] this Article argues that, as of now, China is in a better position than the United States because it has not only the unique opportunity to learn from mistakes made in the U.S. shale development process,[38] but also the ability to develop its shale gas resources without the obligation of having to balance private interests and correlative rights of the resource. This major difference gives China the ability, advantage, and significant opportunity to produce shale gas in a sustainable way. In other words, because the Chinese government owns all Chinese minerals,[39] it can meticulously shape the country's shale

34. Wang Canfa, *Chinese Environmental Law Enforcement: Current Deficiencies and Suggested Reforms*, 8 VT. J. ENVTL. L. 159, 161 (2007).

35. SOPHIA SUN, ALBERTA CHINA OFFICE, SHALE GAS DEVELOPMENT IN CHINA – 1, at 2 (2013), http://albertacanada.com/china/documents/ShaleGasDevelopmentInChina.pdf (acknowledging concerns about the location of the shale gas deposits, the development of China's pipeline network, and China's manufacturing capacity).

36. Yang & Liu, *supra* note 9, at 17.

37. Neil Gunningham, *A Shale Gas Revolution for China?*, 14 CLIMATE POL'Y 302, 315 (2013); Sarah M. Forbes, The United States and China: Moving Toward Responsible Shale Gas Development 9 (Sept. 2013) (unpublished manuscript), http://brookings.edu/~/media/events/2014/2/06%20china%20clean%20energy/uschina%20moving%20toward%20responsible%20shale%20gas%20development_sforbes.

38. *See* H. Allen Klaiber et al., Missing the Forest for the Trees: Balancing Shale Exploration and Conservation Goals Through Policy 11 (Jan 1, 2016) (unpublished manuscript), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2772781.

39. Yu, *supra* note 25, at 34.

gas development — focusing on conservation and sustainability — without private landowner intervention.

II. BACKGROUND: CHINA'S FRACKING SOLUTION TO ITS ENERGY PROBLEMS

A. What is Fracking?

Although U.S. oil and gas industry stretches back almost a century,[40] by comparison, the ability to produce gas from shale formations is relatively new.[41] Several technological milestones contributed to the shale gas revolution. In order to understand the difference between recovery of hydrocarbon resources from conventional sources, such as oil from traditional vertical wells, and unconventional sources, such as shale gas, a brief overview of the relevant physical geology is important.

Generally, shale gas is a term used to denote natural gas that is trapped in tight shale formations, which restricts the gas's free flow through conventional vertical wellbores.[42] Instead of flowing easily from the earth like it would from conventional reserves, the shale gas formation must first be broken up to allow the gas to move more freely.[43] This is where fracking comes in. The force of the injected fluids breaks up the geological formation by creating small fissures, which are propped open with small pieces of rock and other materials, allowing oil and gas to migrate more freely.[44]

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40. *Id.*, at 30. Modern-day hydraulic fracturing was developed in the United States in the 1990s. Jeff McMahon, *Six Reasons Fracking Has Flopped Overseas*, FORBES (Apr. 7, 2013, 9:00 AM), http://forbes.com/sites/jeffmcmahon/2013/04/07/six-reasons-fracking-has-flopped-overseas/.

41. Fallon & Ji, *supra* note 14, at 1-3 (looking at the rapid growth in shale gas production since 2008 and the multiple state and federal agencies that currently regulate the extraction of oil and gas).

42. Yu, *supra* note 25, at 30.

43. This technique creates cracks in the shale when a mixture of water, fracking fluids, and sand is pushed into the nonporous formation. U.S. DEP'T OF ENERGY, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES 13-14, 56 (2009), http://energy.gov/sites/prod/files/2013/03/f0/ShaleGasPrimer_Online_4-2009.pdf [hereinafter MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES].

44. MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES, *supra* note 43, at 13-14. The analogy of a sponge is often used. Think of conventional hydrocarbon reservoirs as a sponge. If a sponge is saturated with water, one could stick a straw in it and suck out all the water as the sponge squeezed — the squeezing, of course, simulating the natural

Fracking can be used with almost any geologic formation that may contain large quantities of gas (or oil) but has low permeability and a low flow rate,[45] or in situations where the formation is damaged or there is a clog during the drilling process.[46]

B. Why Does China Need Fracking?

Realizing the seriousness of its current reliance on coal for energy and the pressing concern for public health caused by pollution levels, the Chinese government is seeking to increase energy produced from natural gas and decrease its reliance on coal, effectively substituting coal, the burning of which causes high levels of pollution, with cleaner burning natural gas. New shale gas exploration comes at an important time for China.[47] China's reliance on coal is still rising steadily.[48] In fact, coal has been the primary source of the electricity that has powered China's expanding economy over the past few decades — too long,

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pressure exerted on underground hydrocarbon reserves by the weight of the rock on top of it. Shale gas, by way of comparison, is more like a clay brick. While there may be a similar amount of water in the brick, simply opening a channel of lower pressure to allow the pressurized water to flow out is not enough. The brick does allow water to flow as freely through it. Instead, channels must be opened first — which is done through fracking — before the water may flow as freely under the same pressure.

45. *Hydraulic Fracturing 101*, EARTHWORKS, http://earthworksaction.org/issues/detail/hydraulic_fracturing_101#.VpVSTDb1—I (last visited Jan. 28, 2016). In these situations, removing gas from the shale formation is not economical without fracking. *What is Shale Gas?*, GEOLOGY.COM, http://geology.com/energy/shale-gas/ (last visited Apr. 12, 2016). Ali Daneshy, *Hydraulic Fracturing to Improve Production*, 6 WAY AHEAD 14, 14, 17 (2010).

46. *Hydraulic Fracturing 101*, *supra* note 45. Fracking is relevant not just for shale, but also for tight sand and coal-bed methane formations. *Id.* Together, shale, tight sands, and coal bed methane comprise sixty percent of the onshore recoverable resources in the United States.

47. *China Consumes Nearly as Much Coal as the Rest of the World Combined*, U.S. ENERGY INFO. ADMIN. (Jan. 29, 2013), http://eia.gov/todayinenergy/detail.cfm?id=9751.

48. *See* Damian Tobin, *Slowing Growth and Economic Rebalancing in China*, 95 OXFORD ENERGY F. 4, 5 (2014) (explaining that China's ambitious targets to reduce its dependence on coal and other fossil fuels "will require an increasing emphasis on 'green' technology and sustainable energy sources," but "[t]his appears at odds with the continued reliance on, and expansion of, coal and oil enterprises").

some argue.[49] China consumes, produces, and imports more coal than any other country in the world.[50] Coal constitutes nearly two-thirds of China's total energy consumption, which has prompted the Chinese government to begin considering capping coal use in hopes of mitigating some of the more serious environmental effects.[51] This widespread burning of coal is a major contributor to the pollution haze that blankets the air above Chinese cities, including China's capital Beijing, which has struggled with hazardous levels of smog.[52]

One report ranked seven Chinese cities among the world's ten most polluted cities.[53] Another report lists China as "home to 16 of the world's 20 most polluted cities."[54] Thus, it is not surprising that natural gas is seen as the "fuel of choice" to help address China's pollution issues.[55] Switching from coal to natural gas would reduce airborne sulfur, nitrogen, mercury, and other

49. Justin Loiseau, *Can Fracking Save China From Coal?*, MOTLEY FOOL (Aug. 5, 2014, 9:48 AM), http://fool.com/investing/general/2014/08/05/can-fracking-save-china-from-coal.aspx.

50. CHINA: OVERVIEW, *supra* note 2, at 1.

51. *Id.* at 2.

52. *Beijing Aims to Switch from Coal to Natural Gas*, *supra* note 6. The magnitude of China's urban pollution problems has been documented by photo journalists, especially during winters when "cool air is trapped by above lying warm air that acts as a blanket prohibiting circulation and trapping pollution." Trevor Nace, *Beijing Declares 'Red Alert' Over Pollution: Haze Visible from Space*, FORBES SCIENCE (Dec. 9, 2015), http://www.forbes.com/sites/trevornace/2015/12/09/beijing-declares-red-alert-pollution-haze-visible-space. *See generally* Adam Vaughan, *Nine Chinese Cities Suffered More Days of Severe Smog than Beijing*, GUARDIAN (Mar. 12, 2014), http://www.theguardian.com/environment/2014/mar/12/china-smog-pollution-beijing (explaining how most of the top ten cities in China suffering from severe smog are "home to a large number of coal-fired power plants and industries including steel and cement that burn coal").

53. QINGFENG ZHANG & ROBERT CROOKS, ASIAN DEV. BANK, TOWARD AN ENVIRONMENTALLY SUSTAINABLE FUTURE 55 (2012), http://adb.org/sites/default/files/pub/2012/toward-environmentally-sustainable-future-prc.pdf.

54. Kai N. Lee, *An Urbanizing World*, *in* STATE OF THE WORLD 2007, at 3, 9 (Linda Starke ed., 2007).

55. MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES, *supra* note 43, at 3-6.

particulates that cause air pollution.[56] Specifically, gas emits half the GHG per unit of electricity as coal.[57]

Chinese industries have been dependent on coal for too long.[58] In 2013, China banned new coal-fired power plant construction in the Beijing, Shanghai, and Guangdong regions, and required "reduction and substitution projects" for preexisting projects.[59] Moreover, the Chinese government has vowed to reduce the proportion of China's fossil fuel consumption below sixty-five percent of energy use by 2017.[60] Just as the United States began replacing "dirty coal with cleaner oil" after World War II, China seeks to replace its dirty coal with cleaner gas.[61]

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56. Robert B. Jackson et al., *The Environmental Costs and Benefits of Fracking*, 39 ANN. REV. ENV'T & RES. 7.1, 7.20 (2014).

57. Gunningham, *supra* note 37, at 303 (comparing situations when coal is combusted in current-generation combined cycle gas turbine power stations). Natural gas is also mainly composed of methane, which almost completely burns with little air pollution or ash. *Id.*; *Natural Gas Fueling the Blue Flame*, U.S. DEP'T OF ENERGY, https://fossil.energy.gov/education/energylessons/gas/index.html (last updated Feb. 12, 2013).

58. Gunningham, *supra* note 37, at 303 (showing a graph of China's increasing coal consumption since 1980, and characterizing coal as China's primary power source). In 2013, to address its coal dependence, China's State Council created the *Atmospheric Pollution Prevention Action Plan*, calling for the use of natural gas in order to improve the country's air quality by 2017. Yang & Liu, *supra* note 9, at 16; STATE COUNCIL ON THE ISSUANCE OF AIR POLLUTION CONTROL PLAN OF ACTION NOTIFICATION, THE CENTRAL PEOPLE'S GOV'T OF CHINA, AIR POLLUTION CONTROL ACTION PLAN (2013).

59. THE CENTRAL PEOPLE'S GOV'T OF CHINA, *supra* note 58; Barbara Finamore et al., *China Pledges to Tackle Air Pollution with New Plan*, NAT'L RES. DEF. COUNCIL: SWITCHBOARD (Sept. 13, 2013), http://switchboard.nrdc.org/blogs/bfinamore/china_pledges_to_tackle_air_po.html.

60. David Stanway, *China to Cut Coal Use, Shut Polluters, in Bid to Clear the Air*, REUTERS (Sept. 12, 2013, 2:26 AM), http://www.reuters.com/article/us-china-coal-pollution-idUSBRE98B01N20130912.

61. *See* Frank Wang & Hongfei Li, *Environmental Implications of China's Energy Demands*, *in* CHINA'S ENVIRONMENT AND THE CHALLENGE OF SUSTAINABLE DEVELOPMENT 180, 180, 196-97 (Kristen A. Day ed., 2005) (explaining that "China's aggressive energy development projects in the areas of hydroelectric power, natural gas, and nuclear power tend to be risky", but perhaps what has been characterized by some as "monumental environmental gambles" may help China, just as replacing coal with oil played a pivotal role in the economic expansions of the United States and Europe after World War II). The United States has been concerned about its energy independence since World War II. See e.g., Stephen P. A. Brown & Mine K. Yücel, *The Shale Gas and Tight Oil Boom: U.S. States' Economic Gains and Vulnerabilities*, COUNCIL ON FOREIGN RELATIONS (Oct. 2013), http://www.cfr.org/united-states/shale-gas-tight-oil-boom-us-states-economic-gains-vulnerabilities/p31568.

The availability of domestic fuel may ease China's energy security concerns, which have been growing commensurate with China's dependence on foreign sources of natural gas.[62] Overall, Chinese energy imports are forecasted to double by 2035.[63] China's demand for natural gas quadrupled from 2000 to 2010.[64] Demand surpassed supply in 2009,[65] and Chinese dependence on energy imports has been increasing ever since.[66] The demand for natural gas imports is even growing faster than the demand for oil or coal.[67] The International Energy Agency ("IEA") predicts that by 2017 China's gas consumption will have doubled from the 2011 levels.[68] Viable shale production may help cut China's dependence on imports by up to forty percent,[69] alleviate China's dependence on fossil fuel imports, reduce GHG emissions, and provide economic and energy security benefits.[70]

62. Gunningham, *supra* note 37, at 303 (stating that China has become more dependent on traditional energy imports of coal, oil, and natural gas and is projected to more than double by 2035); BRIT. PETRO., *supra* note 19, at 45; *see* Ming Zeng et al., *China's Shale Gas Development Outlook and Challenges*, POWER MAG. (Jan. 1, 2014), http://powermag.com/chinas-shale-gas-development-outlook-and-challenges/ (providing statistics on China's increasing imports of foreign oil, coal, and natural gas); STEVEN W. LEWIS, THE GEOPOLITICS OF NATURAL GAS – NATURAL GAS IN THE PEOPLE'S REPUBLIC OF CHINA 6 (2013), http://belfercenter.hks.harvard.edu/publication/23557/natural_gas_in_the_peoples_republic_of_china.html?breadcrumb=%2Fproject%2F68%2Fgeopolitics_of_energy_project; King & Spalding, *Natural Gas Imports into China – Prospects for Growth*, JD SUPRA (Sept. 10, 2014), http://jdsupra.com/legalnews/natural-gas-imports-into-china-prospec-37365/ 106 (noting China is predicted to become the world's largest energy importer by 2035).

63. BRIT. PETRO., *supra* note 19, at 45.

64. Zeng et al., *supra* note 62.

65. *Id.*

66. *Id.*

67. *Id.*

68. IEA REPORT, *supra* note 14, at 13.

69. Katy Barnato, *US-China Shale Gas Rivalry Bad News for Poor Countries*, CNBC: ENERGY FUTURE (May 6, 2014, 7:08 PM), http://cnbc.com/id/101646609; Jingzheng Ren et al., *Sustainability, Shale Gas, and Energy Transition in China: Assessing Barriers and Prioritizing Strategic Measures*, 84 ENERGY 551, 551 (2015).

70. JANE NAKANO ET AL., PROSPECTS FOR SHALE DEVELOPMENT IN ASIA v, 7 (2012), http://csis.org/files/publication/120911_Nakano_ProspectsShaleGas_Web.pdf.

III. DEVELOPMENT OF SHALE IN CHINA

China's natural gas industry and shale gas exploration are still in their infancy.[71] Progress has been made — albeit slowly[72] — despite significant hurdles.[73] First, although China has an abundance of shale gas,[74] its shale exploration and development started much later than in the United States,[75] where modern day hydraulic fracturing began in 1998.[76] In addition, China has a short shale gas production history: although the first Chinese shale was discovered in 1966, China did not start investigating or drafting a national shale gas extraction strategy until 2009.[77] Since then, the Ministry of Land and Resources ("MLR") has conducted a national evaluation of shale gas resource potential and designated favorable areas for production,[78] and other

71. Gunningham, *supra* note 37, at 303. Although China's total natural gas consumption is relatively high, natural gas has never traditionally been a big player in meeting China's energy demands. For example, natural gas only made up three percent of China's energy use in 2011. *See e.g., Natural Gas Serves a Small, but Growing, Portion of China's Total Energy Demand*, U.S. ENERGY INFO. ADMIN. (Aug. 18, 2014), http://www.eia.gov/todayinenergy/detail.cfm?id=17591; Wang & Li, *supra* note 61, at 186.

72. *See* Downie & Drahos, *supra* note 16, at 2 (stating that acquiring technology has been slow).

73. *See* Song Yen Ling, *China Cuts 2020 Shale Gas Output Target as Challenges Persist*, PLATTS MCGRAW HILL FIN. (Sept. 18, 2014, 12:11 AM), http://platts.com/latest-news/natural-gas/singapore/china-cuts-2020-shale-gas-output-target-as-challenges-27641138 (explaining that "Chinese companies' lack of technology and skilled personnel, complex geology as well as a less-than-ideal regulatory framework" creates significant obstacles).

74. *See* ADVANCED RES. INT'L, INC., EIA/ARI WORLD SHALE GAS AND SHALE OIL RESOURCE ASSESSMENT, at XX-1 to XX-2 (2013),http://adv-res.com/pdf/A_EIA_ARI_2013%20World%20Shale%20Gas%20and%20Shale%20Oil%20Resource%20Assessment.pdf (showing a map of China's seven most prospective shale gas and shale oil basins and describing the locations of China's potential shale oil, China has an abundance of shale gas in seven prospective basins, which are mostly concentrated in "marine- and lacustrine-deposited source rock shales of the Sichuan").

75. *See* Yu, *supra* note 25, at 30 (explaining that the United States was the only country in the world with commercial exploration for a number of years, and the subsequent growth of U.S shale gas has spurred China to develop their own natural gas resources).

76. Russell Gold, *When Did the Energy Industry Begin Fracking?*, HUFFPOST GREEN (Mar. 24, 2014, 10:09 AM), http://www.huffingtonpost.com/quora/when-did-the-energy-indus_b_5019285.html.

77. Yuan et al., *supra* note 31, at 195.

78. Yu, *supra* note 25, at 31.

government departments have investigated forty-one basins and areas, eighty-seven evaluation units, and fifty-seven gas-bearing shale sections.[79] In 2010, China completed its first successful fracking exercise using U.S. fracturing technology.[80] A year later, China drilled its first horizontal shale gas well in Sichuan.[81] By 2012, $1.13 billion USD have been invested towards exploring China's shale.[82] As of July 2014, China has carved out fifty-four shale gas blocks in an area covering 170,000 square kilometers.[83] In addition, 400 wells have been drilled — 130 of which are horizontal[84] — with cumulative investment reaching 20 billion RMB (or approximately $3 billion USD).[85] There can be no doubt that progress has been made, but despite these breakthroughs, China was still forced to cut its 2020 shale gas output targets due

79. *Id.*

80. Melanie Hart & Daniel J. Weiss, *Making Fracking Safe in the East and West*, CENTER FOR AMERICAN PROGRESS (Oct. 2011), https://cdn.americanprogress.org/wp-content/uploads/issues/2011/10/pdf/china_fracking.pdf; Fei Kwok & Barbara Li, *China – Shale Gas Handbook*, LEXOLOGY (June 2015), http://www.lexology.com/library/detail.aspx?g=49d6add8-ea49-4254-bed9-20ad278718ef.

81. Yu, *supra* note 25, at 31; Jonathan Watts, *China Takes Step Towards Tapping Shale Gas Potential with First Well,* GUARDIAN (Apr. 21, 2011, 6:38 AM), http://theguardian.com/environment/2011/apr/21/china-shale-gas-well (stating that Sichuan is currently the preferred area for shale gas exploration and development).

82. KPMG GLOBAL ENERGY INSTITUTE, SHALE DEVELOPMENT: GLOBAL UPDATE – FOCUS ON US, CHINA, ARGENTINA, AUSTRALIA, INDONESIA, AND UK 11 (2013), http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/shale-gas/Documents/shale-development-global-update.pdf.

83. 我国页岩气勘查开发稳步推进, MINISTRY OF LAND AND RESOURCES OF THE PEOPLE'S REPUBLIC OF CHINA (Sept. 18, 2014), http://www.mlr.gov.cn/xwdt/zsdwdt/201409/t20140918_1330243.htm.

84. *Id.*; Jiang Zhenxue et al., *The Main Control Factors for Shale Gas Accumulation and Exploration Problems in Shale Gas of South China*, 89 ACTA GEOLOGICA SINICA 250, 250 (2015).

85. MINISTRY OF LAND AND RESOURCES OF THE PEOPLE'S REPUBLIC OF CHINA, *supra* note 83. As of December that year, Sinopec has completed 75 test wells at its Fuling shale gas field. Press Release, Sinopec Corp., Sinopec Releases First Shale Gas ESG Report in China (Dec. 29, 2014), http://english.sinopec.com/media_center/news/20141231/33452.shtml; A total investment of $23 billion RMB had been invested by the end of 2014. *多元投资格局面上形成— 带你了解页岩气资源情况* [*Multiple Investment Situation in Shale Gas Exploration Was Formed—Take You Through the Situation of Shale Gas Resource in China*], MINISTRY OF LAND AND RESOURCES OF CHINA (OCT. 20, 2015), http://www.mlr.gov.cn/xwdt/jrxw/201510/t20151020_1384624.htm.

to persistent challenges, including the lack of technological sophistication and financial impediments.[86]

While current shale production goals are "falling short" of original production targets, "[s]everal industry analysts anticipate China's shale gas production will play a significant role in the natural gas supply after 2020."[87] However, China has reason to be optimistic about its shale, and the government has renewed its commitment to develop this domestic resource because shale gas supply dwarfs its conventional gas counterpart.[88] In fact, this vast supply of natural gas is trapped in what is arguably the largest shale gas reserve in the world[89]: China has almost 80% more technically recoverable shale gas than the United States.[90]

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86. *See* Song, *supra* note 73 (referring to the Ministry of Land and Resources who acknowledged that some companies lack the necessary expertise and in some cases, financial clout).

87. CHINA: OVERVIEW, *supra* note 2, at 26.

88. *See* Wu & Yang, *supra* note 285, at 799.

89. Ren et al., *supra* note 69, at 551 (stating that China has the largest potential of shale gas resource in the world); Biello, *supra* note 8; *Analysis & Projections: World Shale Resource Assessments*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/analysis/studies/worldshalegas/ (last updated Sept. 24, 2015). China has seven assessed shale gas resources: Sichuan, Tarim, Junggar, Songliao, the Yangtze Platform, Jiangshan, and Greater Subei, as well as two major shale plays — Southern and Northern Formations. James W. Adams et al., *Emerging Centrifugal Technology in Shale Hydraulic Fracturing Waste Management: A U.S.-France-China Selected Environmental Comparative Analysis*, 34 HOUS. J. INT'L L. 561, 572 (2012); ADVANCED RES. INT'L, INC., *supra* note 74, at app. C-4. In fact, China's Ministry of Land and Resources allocated thirty-three million RMB to assess and appraise China's vast reserves. *See* INT'L ENERGY AGENCY, MEDIUM-TERM OIL & GAS MARKETS 189 (2010), http://iea.org/publications/freepublications/publication/mtogm2010.pdf. Initial evaluations conducted in 2011 reported China's potential resources of shale gas to be about 134.42 tcm. *See* Yu, *supra* note 25, at 31 (stating this estimate does not count Qinghai-Tibetan land). However, estimates of China's shale gas potential vary significantly. *See* Haipeng Li & Zaixing Jiang, *Progress and Prospects for Shale Gas Exploration and Development in China*, 962-65 ADVANCED MATERIALS RES. 600, 600 tbl.1 (2014) (listing in trillion cubic feet the estimated amount of shale gas resource by the U.S. Energy Information Administration, International Energy Agency, China's Ministry of Land and Resources, and China's National Petroleum Corporation at 1,274.85, 918.18, 886, and 1,084, respectively).

90. ADVANCED RES. INT'L, INC., *supra* note 74, at 6 (stating that the EIA estimates China's technically recoverable shale gas resources to be 1,115 trillion cubic feet (tcf) and the United States to be665 tcf). In addition, the characteristics of China's shale rock also allows for a stable and long gas production lifetime. *See e.g.,* Xingang Zhao et al., *Focus on the Development of Shale Gas in China — Based on SWOT Analysis*, 21 RENEWABLE &

IV. SHALE GAS IN THE UNITED STATES: REGULATION AND INDUSTRY

To date, the United States is the only country to have fully embraced fracking.[91] The first revolution in the then-fledgling oil and gas industry was the practice of horizontal drilling, which was used as early as the 1930s.[92] While the first fracked well was recorded in 1947,[93] it would take several decades until commercial application gained wide use. It was not until 1997, when Mitchell Energy developed slickwater fracturing, that extraction of shale gas became economical.[94] The successful combination of fracking with horizontal drilling has changed the environmental, social, and economic landscape by allowing commercial drillers to reach otherwise inaccessible shale gas deposits.[95] It is estimated that the ability to reach previously inaccessible deposits has doubled the amount of recoverable gas reserves in the United States.[96]

A convoluted framework of federal, state, and local laws regulates shale gas development and production in the United States.[97] Under government oversight, states have the right to apply their own fracking rules to unconventional gas drilling.[98] At

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SUSTAINABLE ENERGY REVS. 603, 607 (2012) (stating that China's shale rocks are thick and generally contain large amounts of gas).

91. Barnato, *supra* note 69; *Hydraulic Fracturing 101*, *supra* note 45.

92. Stevens, *supra* note 20, at 2.

93. *Id.*

94. Finkel, *supra* note 12, at xv.

95. Sakmar, *supra* note 26, at 370-71; MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES, *supra* note 43, at ES-3.

96. *U.S. Natural Gas Resources More than Doubled in the Last Year*, NAT. GAS SUPPLY ASS'N, http://ngsa.org/download/issues/fact-sheets/final%202013%20gas%20resource%20chart.pdf (last visited Feb. 4, 2016); Pierce, *supra* note 6, at 22; *See* Gunningham, *supra* note 37, at 304 (discussing the significant implications that shale gas production has had on the energy landscape of the United States); Sakmar, *supra* note 21, at 370-72 (examining shale gas as an energy "game changer" and the United States' influence on foreign countries that are developing their own shale gas resources); AM. PETRO. INST., HYDRAULIC FRACTURING: UNLOCKING AMERICA'S NATURAL GAS RESOURCES 2 (2015), http://api.org/~/media/files/oil-and-natural-gas/hydraulic-fracturing-primer/hydraulic-fracturing-primer-2015-highres.pdf (discussing the creation of jobs due to shale gas production and the resulting economic growth).

97. MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES, *supra* note 43, at 25.

98. U.S. DEP'T OF ENERGY, DOE/NETL-2014/1651, ENVIRONMENTAL IMPACTS OF UNCONVENTIONAL NATURAL GAS DEVELOPMENT AND PRODUCTION 18 (2014), http://netl.

the wholly intrastate regulatory level, shale gas development can fall under the purview of state oil and gas agencies, state environmental agencies, or a combination thereof.[99] Sixteen states currently have or are expected to have shale gas development.[100] Several states have also devised regulatory schemes typically consisting of two agencies to deal with the environmental ramifications of their respective oil and gas industries — one focusing on conservation and development of the resource and the other on regulation of the resource.[101] The primary drawback, of course, is that regulation at the local level is often specific to the geography and social norms prevailing in that state. In practice, this means that the technology or regulation beneficial in Texas might not work in Pennsylvania, resulting in inconsistent regulation across the fifty states.[102]

Even if one were to ignore inconsistencies between state regulations, inconsistency also exists at the federal level as well: The U.S. Environmental Protection Agency (EPA) administers most federal law affecting the oil and gas industry, but a number of other federal agencies, such as the Department of Energy (DOE), Department of the Interior (DOI), and the Securities and Exchange Commission (SEC), also have regulatory authority affecting the oil and gas industry.[103] Still more agencies are

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doe.gov/File%20Library/Research/Oil-Gas/publications/NG_Literature_Review3_Post.pdf [hereinafter ENVIRONMENTAL IMPACTS].

99. *Shale Gas 101*, OFFICE OF FOSSIL ENERGY, http://energy.gov/fe/shale-gas-101 (last visited Feb. 18, 2016); U.S. DEP'T OF ENERGY, DOE/NETL-2014/1651, ENVIRONMENTAL IMPACTS OF UNCONVENTIONAL NATURAL GAS DEVELOPMENT AND PRODUCTION 18 (2014), http://netl.doe.gov/File%20Library/Research/Oil-Gas/publications/NG_Literature_Review3_Post.pdf [hereinafter ENVIRONMENTAL IMPACTS].

100. ENVIRONMENTAL IMPACTS, *supra* note 99, at 18.

101. Thomas E. Kurth, Note, *Understanding Hydraulic Fracturing: Issues, Challenges and Regulatory Regime*, WESTLAWNEXT & PRACTICAL L. FIN. (2015). An example includes Texas, where the Texas Railroad Commission has primary regulatory jurisdiction but the Texas Commission of Environmental Quality has general environmental jurisdiction.

102. *See* Laura C. Reeder, Note, *Creating a Legal Framework for Regulation of Natural Gas Extraction from the Marcellus Shale Formation*, 34 WM. & MARY ENVTL. L. & POL'Y REV. 999, 1001 (2010) (explaining that the environmental threats are unique between the two states).

103. *See* MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES, *supra* note 43, at 25 (explaining the regulatory framework in the United States governing shale gas); ENVIRONMENTAL IMPACTS, *supra* note 98, at 15 (describing the varying competencies of

involved when oil and gas operations take place on public lands. In addition to the aforementioned agencies, federal agencies such the Bureau of Land Management, the National Park Service, the Occupational Safety and Health Administration, and the U.S. Forest Service are in charge of enforcing regulation of onshore unconventional gas wells.[104] Thus, friction exists with many federal, state, and sometimes even city regulations involved, and the chance of miscommunication and lack of coordination is high.[105]

V. CHINA'S REGULATORY FRAMEWORK FOR ENERGY POLICIES

The growth forecast of China's demand for energy and its aspirations "to embrace both cleaner and more efficient energy sources" have made domestic natural gas production a high priority.[106] The Chinese government is optimistic that China's shale gas is capable of starting a clean revolution.[107] In fact, China is estimated to be the second largest shale gas producer by 2035.[108] However, the existing regulatory framework lacks adequate provisions governing shale gas extraction and related environmental concerns,[109] and a legal framework that explicitly regulates the development of shale gas is not expected to come to

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government agencies responsible for unconventional natural gas development and energy); *see generally* Kurth, *supra* note 101 (listing the different regulatory bodies that govern under federal law).

104. ENVIRONMENTAL IMPACTS, *supra* note 98, at 15.

105. *See* Kurth, *supra* note 101 (concluding that the regulatory uncertainty surrounding the state and federal regulations has led public companies modifying their risk factors in public filings).

106. *See* King & Spalding, *supra* note 62 (explaining that China plans to achieve its goal of reducing environmental pollution by not only prohibiting the construction of new coal-fired power plants, but also by increasing the amount electricity powered by natural gas, as it is the cleanest burning fossil fuel); ExxonMobil, The Outlook for Energy: A View to 2040, at 20 (2015) (noting that "increasing domestic natural gas production is a strategic priority for China").

107. *See* Gunningham, *supra* note 37, at 303 (inferring that the Chinese Government is optimistic about shale gas due to a government official stating that shale gas development will trigger an energy "revolution" in China).

108. *China to Become World's Second-Largest Shale Gas Producer by 2035: BP*, CHINA CLIMATE CHANGE INFO-NET (May 5, 2015), http://en.ccchina.gov.cn/Detail.aspx?newsId=52402&TId=96.

109. *Id.* at 9.

fruition until there has been a successful demonstration of production.[110]

Although shale gas production has the potential to generate vast economic benefits, China still lacks a comprehensive legal framework to address the potential environmental hazards associated with such production.[111] In fact, China has no laws that explicitly address the environmental risks of fracking.[112] China does, however, have a number of general laws that play a role in shale gas production.[113] For example, as discussed more fully below, China has generally applicable environmental laws that are implicated by shale gas production, but there is no specific regulation of methane emissions. Methane leaks are a particular risk associated with shale gas production,[114] so the absence of tailored regulation means that producers need not limit methane emissions at shale gas wells. As such, this particular risk posed by producing shale gas goes unaddressed.[115]

This dearth of regulation is particularly troubling in light of how harmful methane release can be — it is seventy-two times more toxic than carbon dioxide.[116] In particular, local municipal governments are incentivized to prioritize economic benefits over environmental protection; food on the table is often prioritized over risks to the environment, the consequences of which are not nearly as imminent or personal to the individuals in the area.[117] Government-mandated performance assessments show that economic development goals prevail over environmental

110. Zeng et al., *supra* note 62; Forbes, *supra* note 37, at 8-9.

111. Alan Krupnick et al., *Environmental Risks of Shale Gas Development in China*, 75 ENERGY POL'Y 117, 124 (2014) (discussing the ineffectiveness or lack of environmental regulations in China).

112. Forbes, *supra* note 37, at 8-9 (noting that "environmental regulations and standards . . . are not expected until after successful demonstration of shale gas production.").

113. Gunningham, *supra* note 37, at 313.

114. Because fracking creates new fissures in subterranean rock formations, it is exceedingly difficult to predict accurately whether those new fissures will serve as conduits, either in isolation or by connecting to a preexisting fissure, through which subterranean pockets of methane gas may migrate up to the surface.

115. Wang Xiaocong, *Environmental Frets as Frackers Move In*, CAIXIN ONLINE (Nov. 20, 2012, 12:59 PM), http://english.caixin.com/2012-11-20/100462881.html.

116. Tomain, *supra* note 21, at 1205.

117. Wang, *supra* note 34, at 171.

protection, as "economic growth is one of the primary metrics of performance[,] and environmental performance measures are virtually non-existent."[118] However, China has recently been working on industry-specific rules and policies that relate to shale gas, which will be discussed below. For example, Sinopec released a report on the environmental and social impacts of shale gas development in December 2014.[119]

By way of background, the Chinese legislative process can be broken down as follows: laws are enacted, regulations are passed, and rules are created.[120] The regulatory framework for China's energy policies can be divided into three general time periods: (1) Planned Economy Period; (2) Economic Transition Period; and (3) the New Era.[121] The first period began with Planned Economy Period (1950-1980s) when the Organic Law of the Fuel Industry established the Ministry of Fuel Industry ("MFI") to regulate the coal, oil, and electricity industries.[122] During this time, energy regulation was basically unnecessary because there was effectively no separation between the Chinese government and market.[123]

The second period came after China launched its economic reform policies in 1978, propelling energy regulation to go through a transition period until the early 1990s.[124] During this transition, legislation focused on establishing a legal foundation for opening and diversifying the energy market.[125] One of the hallmark pieces of legislation enacted during this time was the 1986 Mineral Resources Law, which sought "utilization and protection of mineral resources and to ensur[e] the present and long-term requirements of the socialist modernization."[126]

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118. Wang, *supra* note 7, at 198-99.

119. Sinopec Corp, *supra* note 85.

120. *Id.* at 18.

121. *See* Qiu & Li, *supra* note 13, at 10678-79 (discussing the three relevant time periods in regards to China's changing energy policies).

122. *Id.* at 10678.

123. *Id.*

124. *Id.* at 10679.

125. *Id.*

126. Mineral Resources Law of the People's Republic of China (promulgated by the President of the People's Republic of China, Mar. 19, 1986, effective Oct. 1, 1986), http://english.mofcom.gov.cn/aarticle/lawsdata/chineselaw/200211/20021100053795.html.

Although steps were taken to move away from the model of a government-controlled energy industry, the legislation during this period was mostly "general principles[,] and the language was ambiguous."[127] But one thing the legislation did accomplish was to signal a shift in policy.

The final period began when China started to embrace energy conservation and reduction of emissions to promote sustainability starting in the 2000s.[128] For example, China enacted its Renewable Energy Law to move away from its coal-centered energy structure and amended its Energy Conservation Law to promote consumption of green energy.[129]

It is unclear how China's legal system will be able to keep up with the rapidly growing desire for shale gas. Specifically, issues arise when trying to "harmonize" these existing regulatory and policy frameworks discussed above.[130] In addition, China's governmental structure is already complex, resembling that of the United States, and as it struggles to keep pace with a rapidly changing socioeconomic landscape, the risk of conflicting industry standards may be exacerbated. The primary governmental organs responsible for setting the rules and regulations for the Chinese people and industries are the National People's Committee, the State Council, and various ministries.[131] Similar to the network of U.S. federal agencies, as outlined above, China has at least seven ministerial level agencies involved with no clearly

127. Qiu & Li, *supra* note 13, at 10679.

128. *Id.*

129. Zhōnghuá Rénmín Gònghéguó Kě Zàishēng Néngyuán Fǎ (中华人民共和国可再生能源法) [People's Republic of China Renewable Energy Law] (promulgated by the Standing Comm. Nat'l People's Cong., Feb. 28, 2005, effective Apr. 1, 2010) art. I, http://www.lawinfochina.com/display.aspx?id=3942&lib=law&SearchKeyword=coal%20law&SearchCKeyword=%BF%C9%D4%D9%C9%FA%C4%DC%D4%B4%B7%A8.

130. Ren et al., *supra* note 69, at 553.

131. *Id.*

delineated responsibilities.[132] At least six of these ministries influence and play some role in China's shale gas policy.[133]

A. Current Shale Gas Policies

China started implementing shale gas industry policies in 2009[134] but was slow to finalize its first shale gas production policy.[135] The reason for this delay was due to the lack of regulation addressing potential environmental hazards of extracting shale gas.[136] In March 2011, the National People's Congress of China finally approved a national development program — called China's Twelfth Five-Year Plan — intended to promote higher quality growth, develop China's western regions, improve the lives of Chinese citizens, and advance seven priority industries, including emphasizing production of unconventional sources, such as shale gas.[137] Subsequently, China developed its main shale gas policy — the Twelfth Five-Year (2011-2015) Plan for Shale Gas (Shale Development Plan), which professes the government's support for shale gas production and sets out four milestone goals: (1) a complete nationwide shale gas survey and appraisal; (2) production outputs; (3) suitable technology and equipment development; and (4) establishment of technical rules,

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132. Ella Chou, Shale Gas in China – Development and Challenges 6 (July 11, 2013) (unpublished manuscript), http://blogs.harvard.edu/ellachou/files/2013/07/Shale-Gas-in-China-Draft.pdf (including the Ministry of Finance (MOF), MLR, NEA, National Development and Reform Commission, Ministry of Commerce, Ministry of Science and Technology, and Ministry of Environmental Protection (MEP)).

133. SANDALOW ET AL., *supra* note 12, at 53; Kwok & Li, *supra* note 80 (stating that National Energy Administration, the Ministry of Land and Resources, the National Development and Reform Commission, and the Ministry of Finance regulate China's shale gas sector).

134. Guanglin Pi et al., *supra* note 15, at 2357.

135. NAKANO ET. AL., *supra* note 70, at 6.

136. Farah & Tremolada, *supra* note 12, at 18-19.

137. KPMG CHINA, CHINA'S 12TH FIVE-YEAR PLAN: OVERVIEW 1-2 (2011), http://www.kpmg.com/CN/en/IssuesAndInsights/ArticlesPublications/Publicationseries/5-years-plan/Documents/China-12th-Five-Year-Plan-Overview-201104.pdf; *People's Republic of China National Economic and Social Development Twelfth Five-Year Plan*, XINHUA NEWS AGENCY (Mar. 16, 2011), http://www.gov.cn/2011lh/content_1825838.htm [hereinafter *Twelfth Five-Year Plan*].

standards, and policies.[138] Knowing the wealth of natural gas that lies in wait beneath the ground, the Shale Development Plan originally set an ambitious goal of producing 6.5 billion cubic meters (bcm) of shale gas per year through 2015.[139] In addition, the Shale Development Plan aimed to increase energy consumption from renewable sources by fifteen percent by 2020.[140] Despite these lofty goals, China opted to cut these targets by nearly half in 2014.[141] Instead, the National Energy Administration predicted that China would produce 30 bcm by 2020, as compared to its 2012 target of 60 bcm.[142]

Moreover, China has continued to focus on developing its natural gas resources by taking steps to implement new energy policies focusing on operational issues,[143] including providing shale gas production subsidies.[144] Pursuant to the Shale

138. Audrey Raj, *Yin and Yang of Chinese Shale Gas*, ASIAN OIL & GAS (May 27, 2015, 10:50 AM), http://aogdigital.com/energy/shale/item/4912-yin-and-yang-of-chinese-shale-gas; Shale Gas Development Plan, *supra* note 12 (setting goals of increasing production to 6.5 bcm per year by 2015 and 60 to 100 bcm by 2020); *China's 12th Five-Year Plan for Shale Gas*, NORTON ROSE FULBRIGHT (Mar. 2012), http://www.nortonrosefulbright.com/knowledge/publications/64620/chinas-12th-five-year-plan-for-shale-gas; Shale Gas Development Plan, *supra* note 12.

139. Haas, *supra* note 27; *Twelfth Five-Year Plan*, *supra* note 137.

140. CHINA: OVERVIEW, *supra* note 2, at 1.

141. Downie & Drahos, *supra* note 11, at 3.

142. *Id.*; This new target is much more realistic than the original "vague prospect" made in 2012, but admission on shale gas reflects the challenges facing China's natural gas market and has negatively impacted oil service sector companies who made investments based on the earlier target. *See* Aizhu Chen et al., *China Finds Shale Gas Challenging, Halves 2020 Output Target*, REUTERS (Aug. 7, 2014, 2:29 AM), http://www.reuters.com/article/us-china-shale-target-idUSKBN0G70GS20140807.

143. *Twelfth Five-Year Plan*, *supra* note 137; Shale Gas Development Plan, *supra* note 12; Shale Gas Policy, *supra* note 144.

144. *关于出台页岩气开发利用补贴政策的通知* [*Notice of the Introduction of Shale Gas Development and Utilization of Subsidies*], 中华人民共和国国家能源局 [NAT'L ENERGY ADMIN.] (Nov. 6, 2012), http://www.nea.gov.cn/2012-11/06/c_131953346.htm; Li Wei, President, Dev. Research Ctr. of the State Council, Address at the Chatham House: Strengthening the Innovation of Energy Technology and Work Together for a Green, Sustainable and Bright Future (July 7, 2014), http://en.drc.gov.cn/2014-07/17/content_17813387.htm. Government policies to encourage shale gas include: (1) production targets; (2) offering subsidies to offset costs; (3) waiver of price controls and fees, such as an exploration rights fee or a mineral resource compensation fee; (4) classifying shale gas as an independent mineral resource; and (5) publishing a shale gas industry standard. SANDALOW ET AL., *supra* note 12, at 22; Yeyaqui Chanye Zhengce (页

Development Plan, the Chinese government followed up with its First Shale Gas Industrial Policy (Shale Gas Industry Policy) in October 2013 to advance foreign investment objectives, energy conservation, and security by focusing on the structural barriers to China's shale gas development.[145] Although this Shale Gas Industry Policy encouraged investments in shale gas infrastructure and construction, it failed to provide concrete strategies on how to expand the industry.[146]

Improvements to existing law have been made, and a number of other laws that may influence shale gas production are also in the works. For example, China's oil and gas pipeline reforms have been ongoing.[147] In October 2012, China's Information Office of the State Council released the *Whitepaper: China's Energy Policy 2012* ("Whitepaper"), which describes China's current energy status, policies, and conservation.[148] The Whitepaper promotes renewable power sources and advocates for China to increase traditional oil field efficiency and meet a larger portion of domestic energy demand with natural gas.[149] In addition, to promote shale gas exploration and development, the Whitepaper sets out objectives for the Chinese government to (1) select a

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岩气产业政策 [Shale Gas Policy] (promulgated by the Nat'l Energy Bd., Oct. 22, 2013), http://zfxxgk.nea.gov.cn/auto86/201310/t20131030_1715.htm.

145. Shale Gas Policy, *supra* note 144; *China's First Shale Gas Policy*, SIDLEY (Nov. 12, 2013), http://www.sidley.com/news/chinas-first-shale-gas-policy-11-12-2013; Martijn Wilder & Jennifer Hughes, *Shale Gas – Global Environmental Law and Regulation: China*, BAKER MCKENZIE (Mar. 2014), http://bakermckenzie.com/files/Uploads/Documents/Global%20EMI/SGELR%20Newsletter/SG-ELR_March%202014%20-%20China.pdf; MINISTRY OF LAND AND RESOURCES OF THE PEOPLE'S REPUBLIC OF CHINA (Dec. 2011), http://www.mlr.gov.cn/zwgk/zytz/201112/P020111231555909398201.doc.

146. MINISTRY OF LAND AND RESOURCES OF THE PEOPLE'S REPUBLIC OF CHINA, *supra* note 145.

147. SANDALOW ET AL., *supra* note 12, at 28-29.

148. INFO. OFFICE OF THE STATE COUNCIL THE PEOPLE'S REPUBLIC OF CHINA, CHINA'S ENERGY POLICY 2012 (Oct. 2012), http://english.gov.cn/archive/white_paper/2014/09/09/content_281474986284499.htm [hereinafter CHINA'S ENERGY POLICY 2012].

149. *China Issues White Paper on Energy Policy*, CHINA CLIMATE CHANGE INFO-NET (Oct. 25, 2012), http://en.ccchina.gov.cn/Detail.aspx?newsId=33687&TId=96%22%20title=%22China%20issues%20white%20paper%20on%20energy%20policy; CHINA'S ENERGY POLICY 2012, *supra* note 148; Xiong Jin et al., *Oil and Gas Regulation in China: Overview*, PRACTICAL LAW, http://uk.practicallaw.com/3-525-3038?q=Oil+and+Gas+Regulation+in+China:+Overview (last visited Feb. 25, 2016).

group of potentially favorable exploration areas, (2) strengthen its efforts to solve technological gaps, (3) incentivize shale gas industry developments, and (4) improve support facilities.[150] That same month, the MLR issued the *Notice on Strengthening the Exploration and Exploitation of Shale Gas and Relevant Supervision and Administration Work* ("Notice 159").[151] This Notice 159 provided guidelines to parties engaged in shale gas activities and delineated the requirements for shale gas exploration and exploitation rights.[152]

In November 2013, China released a decision called the Third Plenum Economic Reform Proposal with the mission of encouraging market forces to play a more decisive role in allocating resources "in the context of government policy and excluding natural monopoly situations."[153] Specifically, the reform designates an expanded role for market forces to determine economic outcomes,[154] including private investment in state-owned enterprises.[155] To reiterate these goals, President Xi Jinping announced a five-part strategy in 2014 to encourage the strengthening of international cooperation as well as a revolution in energy consumption, supply, technology, and governance.[156] In October 2015, the National People's Congress adopted the Thirteenth Five-Year Plan, which further promotes exploration of

150. CHINA'S ENERGY POLICY 2012, *supra* note 148, ch. 5.

151. MINISTRY OF LAND AND RESOURCES OF THE PEOPLE'S REPUBLIC OF CHINA (Nov. 22, 2012), http://www.mlr.gov.cn/zwgk/zytz/201211/t20121122_1158928.htm.

152. *Id.*

153. *Eighteenth Communist Party of China Central Committee of the Third Plenary Session*, COMMUNIST PARTY CHINA NEWS (Nov. 12, 2013), http://cpc.people.com.cn/n/2013/1112/c64094-23519137.html; SANDALOW ET AL., *supra* note 12, at 5; *The Decision on Major Issues Concerning Comprehensively Deepening Reforms*, CHINA DAILY (Nov. 16, 2013), http://www.china.org.cn/china/third_plenary_session/2013-11/16/content_30620736.htm; NARGIZA SALIDJANOVA & IACOB KOCH-WESER, U.S.-CHINA ECON. & SEC. REV. COMM'N, THIRD PLENUM ECONOMIC REFORM PROPOSALS (2013), http://origin.www.uscc.gov/sites/default/files/Research/Backgrounder_Third%20Plenum%20Economic%20Reform%20Proposals—A%20Scorecard%20(2).pdf.

154. *See* SALIDJANOVA & KOCH-WESER, *supra* note 153, at 2 (stating that traditionally the Third plenums focus on economic issues).

155. *Id.* at 3.

156. SANDALOW ET AL., *supra* note 12, at 20-21.

shale gas and control of energy consumption through 2020.[157] In November 2015, to further promote natural gas, the National Development and Reform Commission cut the benchmark price for natural gas sold to nonresidential users by nearly thirty percent.[158] These reforms will not only help shape China's natural gas sector, but also help meet these goals[159] and demonstrate the current leadership's strong commitment to improving the legal system, liberalizing investment, and strengthening environmental regulatory regimes.[160]

VI. SHALE GAS DEVELOPMENT CHALLENGES

Although China is optimistic about its ability to produce shale gas, two main categories of hurdles must be overcome: (1) man-made and (2) geological.[161] Despite the reforms discussed above, environmental laws and regulations are still not specifically addressing the environmental impact of shale gas. For example, in April 2014, the National People's Congress adopted an amended Environmental Protection Law of the People's Republic of China, aimed at ensuring sustainability by protecting the environment from pollution and other hazards.[162] Although "preventing and controlling pollution" is noted as the primary objective of the law, not one of the seventy articles makes specific references to shale gas or oil extraction activities.[163] Moreover, Article 42 addresses "waste gas" by stating: "Enterprises, public institutions and other producers . . . that discharge pollutants shall take measures to prevent and control the environmental

157. *China Unveils Proposal for Formulating 13th Five-Year Plan*, XINHUANET (Nov. 3, 2015), http://news.xinhuanet.com/english/2015-11/03/c_134780352.htm.

158. Fan Ruohong, *Gov't Tries to Spur Natural Gas Use by Trimming Price*, CAIXIN ONLINE (Nov. 19, 2015, 7:05 PM), http://english.caixin.com/2015-11-19/100876253.html.

159. SANDALOW ET AL., *supra* note 12, at 4.

160. SALIDJANOVA & KOCH-WESER, *supra* note 153, at 3-5.

161. *See* Haas, *supra* note 27 (stating that China has an optimistic five-year economic road map of 6.5 bcm of shale gas a year through 2015).

162. Zhōnghuá Rénmín Gònghéguó Huánjìng Bǎ ohù Fǎ (中华人民共和国环境保护) [People's Republic of China Environmental Protection Law] (promulgated by the Standing Comm. Nat'l People's Cong., Apr. 24, 2014, effective Jan 1, 2015), at 1, https://www.chinadialogue.net/Environmental-Protection-Law-2014-eversion.pdf.

163. *Id.* at 1-15.

pollution caused by waste gas."[164] Alas, the Article does not elaborate on these preventative measures, only stating that those institutions "shall each establish an environmental protection accountability system to identify the responsibilities of their persons-in-charge and relevant staff."[165]

Positive results from the implementation of these rules and regulations remain to be seen.[166] Unfortunately, due to the great need for industry expansion, the already laxly enforced laws and policies may prove insufficient. China should first examine the multitude of oil and gas industry regulations. Besides balancing its energy security, competitiveness, and environmental goals, China should also conduct more thorough environmental assessment and enforce specific shale gas environmental law and regulations before expanding its current shale gas production.[167]

A. Man-Made Challenges

Not only have fracking regulations in China not kept pace with the expansion of its domestic natural gas industry,[168] a number of other man-made barriers exist. Fracking operations have already caused complications in China's early stages of exploration and development.[169] Although China may have the

164. *Id.* at 8-9.

165. *Id.*

166. Wang, *supra* note 34, at 161-69 (looking at the numerous environmental laws in China and the various problems with enforcement, including difficulties with implementation, lax investigation, superficial enforcement, and inadequate or delayed punishment); *see* Gunningham, *supra* note 37, at 312 ("Even if, remarkably, China does introduce a range of far-reaching environmental laws, it will still face enormous obstacles in terms of their implementation, monitoring, and enforcement.").

167. *See* Downie & Drahos, *supra* note 16, at 12 (declaring that China, like other major carbon emitting economies, has to manage the three potentially conflicting goals of energy security, competitiveness in global markets and climate/environmental goals); Yu, *supra* note 25, at 37 (stating that no feasibility studies have been conducted on China's shale gas exploration from the environmental impacts perspective, and that laws and regulations related to shale gas exploration for environmental management in China are lacking).

168. *See* McMahon, *supra* note 40 (arguing that one reason why fracking has not been as successful outside the United States is that most of the fiscal terms that other countries have in place are totally incompatible with unconventional development).

169. *See* SANDALOW ET AL., *supra* note 12, at 33 (listing factors that drive up initial production costs, including difficult surface conditions and geology).

shale gas reserves, the country lacks funds, experience, infrastructure, qualified workers, equipment, and facilities.[170]

First, China will need to continue attracting foreign investment and moving towards a market-oriented reform of oil and gas mineral rights. Specifically, China should continue allowing private companies to bid for Chinese shale and lessening the dominance of China's state-owned companies. Continuing its move towards a market-oriented reform of oil and gas mineral rights will change China's existing landscape, including the long-term monopoly of state-owned companies like PetroChina.[171] China National Petroleum Corporation ("CNPC") and the China Petroleum & Chemical Corporation ("Sinopec") control the majority of China's oil and natural gas distribution.[172] Although private companies are more involved with the Chinese gas retail sector than distribution of oil or natural gas,[173] PetroChina, a subsidiary of CNPC, produces approximately seventy-five percent of China's natural gas and sixty-percent of China's crude oil.[174]

The Chinese government's goal of prioritizing the development of its shale gas resources to meet its energy needs has been accomplished, in part, by opening investments to private capital.[175] The government started by only granting exploration and production rights through an application process to state-owned enterprises.[176] While the first round of bidding for shale gas exploration rights was to state- and province-controlled oil and gas enterprises and excluded foreign and private domestic companies,[177] the second round offered more than ten shale

170. Zhao et al., *supra* note 90, at 607-08.

171. Yu, *supra* note 25, at 35. China's national oil companies — CNPC, Sinopec, and China National Offshore Oil Corporation (CNOOC) — are vertically integrated and control much of the natural gas industry. SANDALOW ET AL., *supra* note 12, at 14.

172. Jin et al., *supra* note 149. Before 2012, CNPC and CPDC owned roughly a 90% share of the natural gas market. Wu & Yang, *supra* note 285, at 800.

173. *Id.*

174. *Id.*

175. Zeng et al., *supra* note 62.

176. Jin et al., *supra* note 149.

177. Farah & Tremolada, *supra* note 12, at 7. These state and province-controlled oil and gas enterprises include Sinopec, PetroChina, Yanchang Petroleum, China United Coalbed Methane Corporation, and Henan CBM.

natural gas blocks to privately owned Chinese companies.[178] Because foreign investment is limited to a minority stake in equity joint ventures or cooperative joint ventures,[179] foreign companies must work with qualified Chinese companies.[180] In effect, this allows the Chinese government to control the shale gas industry by auctioning off exploration rights,[181] but it does not amount to an absolute prohibition on foreign-owned companies' participation in the Chinese oil and gas industry.[182] In addition, to overcome the chilling effects of its early reluctance to foreign firms investing in Chinese oil and gas, in 2012, the government issued the Foreign Investment Industry Guidance Catalog to entice foreign investment.[183]

Second, China needs better experience, technology, and public access to geological data.[184] Traditionally, the Chinese government controlled shale gas by auctioning off exploration rights,[185] but it has made a concerted effort to acquire new drilling technology through joint ventures with foreign oil companies, the

178. John Daly, *China to Embrace Fracking in an Effort to Ramp Up Energy Production*, OILPRICE (Nov. 28, 2011, 11:52 PM), http://oilprice.com/Energy/Natural-Gas/China-To-Embrace-Fracking-In-An-Effort-To-Ramp-Up-Energy-Production.html; Zeng et al., *supra* note 62.

179. *国土资源部关于加强页岩气资源勘查开采和监督管理有关工作的通知* [*Ministry of Land and Resources on the Strengthening of Shale Gas Exploration and Exploitation of the Work of Supervision and Management*], MINISTRY OF LAND AND RESOURCES OF CHINA (Nov. 22, 2012), http://www.mlr.gov.cn/zwgk/zytz/201211/t20121122_1158928.htm; Greg Krafka, *How Are Texas Oil and Gas Cos. Faring in China?*, LAW360 (May 19, 2015, 11:28 AM), http://winstead.com/portalresource/lookup/wosid/cp-base-4-28802/overrideFile.name=/Greg%20Krafka_How%20Are%20Texas%20Oil%20And%20Gas%20Cos%20%C2%A0Faring%20In%20China.pdf.

180. *Ministry of Land and Resources on the Strengthening of Shale Gas Exploration and Exploitation of the Work of Supervision and Management*, *supra* note 179.

181. Farah & Tremolada, supra note 12, at 33.

182. In June 2011, the Ministry of Land and Resources implemented a market competition mechanism plan that allowed competitive bidding on four blocks of mineral exploration rights. *See* CHEN WEIDONG ET AL., NAUTILUS INST., CHINA'S SHALE GAS (2014), http://nautilus.org/napsnet/napsnet-special-reports/chinas-shale-gas-current-perspectives/; Yu, *supra* note 25, at 34-35.

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

184. *China's March Towards Shale Gas*, GIDE LOYRETTE NOUEL (Nov. 2013), http://www.gide.com/sites/default/files/gide_china_clientalert_shalegas_en.pdf.

185. Farah & Tremolada, *supra* note 12, at 33.

majority of which have been U.S.-based.[186] As mentioned above, the 2009 U.S-China Shale Gas Resource Initiative announced that the United States and China would share U.S. technology to promote China's shale development goals.[187] In addition, China needs more data, such as well logs, to identify the best locations to drill.[188] However, the Chinese government considers data on basic geology to be state secrets, even though such data is openly available in other countries, so China's need for more data cannot be adequately addressed unless the government loosens its grip on such data.[189]

Third, the lack of infrastructure is another obstacle for China's development of shale gas.[190] Unlike petroleum, which can be transported nationally by road or rail, natural gas needs to be transported via pipeline.[191] In the United States, a vast pipeline network transverses the nation, totaling 460,000 km.[192] In 2012, China's natural gas pipeline network was only one-tenth the size of the U.S. network despite China's natural gas consumption being one-fourth of that consumed in the United States.[193] Currently, China's pipeline infrastructure covers 70,000 kilometers, and the natural gas pipeline system covers roughly two-thirds of that.[194] China's existing pipeline and distribution system provides inadequate coverage to support the receipt, storage, and distribution of natural gas.[195]

In addition to man-made barriers, geological obstacles could also make it comparatively difficult for China to succeed in its

186. Downie & Drahos, *supra* note 16, at 2.

187. Joint Statement by the United States of America and the Republic of China on Clean Energy, *supra* note 32.

188. *See* SANDALOW ET AL., *supra* note 12, at 43-44 (noting that data such as well logs is important to find the "sweet spots," and that the availability of data for shale gas operations is quite limited in China).

189. ADVANCED RES. INT'L, INC, *supr*a note 74, at XX-9.

190. *See* Gunningham, *supra* note 37, at 307 (stating that China does not have an extensive nationwide pipeline network, and that, for example, the Tarim Basin lacks even the basic infrastructure for producing or transporting gas).

191. Zeng et al., *supra* note 62.

192. *Id*.

193. King & Spalding, *supra* note 62.

194. Jin et al., *supra* note 149.

195. King & Spalding, *supra* note 62.

shale gas industry.[196] Compared to the geography of the productive areas for shale gas in the United States, which consists mostly of flat plans, China has a "messy" geology.[197] Fracking is primarily located in the Sichuan area, which is densely populated[198] and has a lot of seismic activity, such as earthquakes due to the presence of fault lines in the region.[199] As a consequence, the use of high-pressure water during the fracking process could exacerbate existing geological risks.[200] Furthermore, drilling in mountainous areas requires more resources, namely infrastructure such as roads and water, which the region currently lacks.[201]

China also has water scarcity problems, which will be substantially aggravated if shale gas production begins to take off.[202] Even if existing U.S. technology can be emulated to reuse and recycle water, it is not clear whether water can be delivered to the drill site given the current lack of Chinese infrastructure and the remote location of some of China's shale basins.[203] China will need to consider various issues, such as water supply management, to alleviate future environmental damage.[204] The 2008 Water Pollution Prevention and Control Law ("WPPCL")

196. *See* Biello, *supra* note 8 (noting that China's deep deposits are folded by faults, making the fracking process more challenging).

197. *China's Fracking Hopes "Shouldn't Be Too High"*, CHINA DIALOGUE: BLOG (Jan. 17, 2013), https://www.chinadialogue.net/blog/5603-China-s-fracking-hopes-shouldn-t-be-too-high-/enc.

198. SANDALOW ET AL., *supra* note 12, at 8, 13.

199. Biello, *supra* note 8; Liu Hongqiao, *Shale Gas on the Intensity Scale*, CAIXIN ONLINE (May 27, 2013, 7:11 PM), http://english.caixin.com/2013-05-27/100533472.html.

200. *Id.*

201. *China's Fracking Hopes "Shouldn't Be Too High"*, *supra* note 197 (noting that the topography and geology of China's most productive regions require a lot of infrastructural development). *See also* Adams et al., *supra* note 89, at 574-75 (stating that development costs in the mountainous regions are increased due to necessary infrastructure improvements including pipelines and roads).

202. *See* Biello, *supra* note 8 (noting that "[t]he key hurdle to China's development of fracking may prove to be water.").

203. *See* Haas, *supra* note 27 (addressing the difficulty of accessing water due to China's mountainous terrain).

204. *See* Farah & Tremolada, *supra* note 12, at 38 (discussing China's need of improved physical infrastructure, such as infrastructures that can safely dispose of contaminated material used to fracture the shale rock); SANDALOW ET AL., *supra* note 12, at 38 ("China faces substantial challenges in managing its water supplies").

outlines China's water policy.[205] Applying to all Chinese fresh water both above and below ground, the WPPCL's purpose is to prevent pollution and protect the environment.[206] Although one of the mandates is to give priority to the prevention of pollution,[207] the Chinese government, like many governments, tends to favor economic growth at the expense of environmental protection.[208] Even when regulations have been adopted, it is unclear whether the law is fully and adequately implemented.[209]

B. Geology

It costs relatively more to build a shale gas well in China than elsewhere because of its complex geology.[210] In the United States, it costs approximately $2.5 million to drill a horizontal well.[211] The cost of a similar well in China can be anywhere from two to ten times as much.[212] A well in China costs at least $10 million

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205. Zhōnghuá Rénmín Gònghéguó Shuǐ Wūrǎ n Fángzhì Fǎ (中华人民共和国水污染防治法) [People's Republic of China Water Pollution Control Act] (promulgated by the Standing Comm. Nat'l People's Cong., Feb. 28, 2008, effective June 1, 2008), http://www.lawinfochina.com/display.aspx?lib=law&id=6722.

206. *Id.* at art. 1-2 (applying to rivers, lakes, canals, irrigation, channels, and other surface water and ground waters).

207. *Id.* at art. 3.

208. Sophie Beach, *China's Fracking Boom and the Fate of the Planet*, CHINA DIGITAL TIMES (Sept. 19, 2014 11:28 A.M), http://chinadigitaltimes.net/2014/09/chinas-fracking-boom-fate-planet/.

209. *See* SANDALOW ET AL., *supra* note 12, at 49-50 (arguing that various agencies' unclear authority and the large number of directives make it difficult for companies, potential investors and the public to know whether or when regulations will be enforced); Wang, *supra* note 34, at 165-66; Gunningham, *supra* note 37, at 312.

210. Haas, *supra* note 27; Raj, *supra* note 138.

211. Paul Deemer, Partner, Vinson & Elkins, RLLP, Presentation at the Centre for Commercial Law Studies, Queen Mary University of London: Legal Issues in Shale Gas Development 6 (Nov. 10, 2014), http://velaw.com/UploadedFiles/VEsite/Presentations/LegalIssuesShaleGasDevelopment.pdf.; Sharon Dunn, *Synergy Surprises Analysts with $2.5 million Per Well Drilling Cost in Weld County*, BAKKEN.COM (Apr. 10, 2015), http://bakken.com/news/id/236689/synergy-surprises-analysts-with-2-5-million-per-well-drilling-cost-in-weld-county/.

212. See Kaixi Huang, *CNPC Plans Spending to Hasten Shale Gas Production in Sichuan*, CAIXIN ONLINE (Oct. 21, 2014, 5:18 PM), http://english.caixin.com/2014-10-21/100741276.html (noting that costs are double those in North America); Raj, *supra* note 138 (explaining that "drilling costs for a shale well in the U.S. is between $2.7-$3.7 million compared to $27-$37 million in China").

and has a lower success rate than U.S. wells.[213] By way of comparison, in order to reach the United States' average annual production of 5 mcm, China would need 1,300 operating wells costing more than 130 billion RMB.[214] Despite the MLR's investment of a total of 660 million into China's shale gas industry between 2009 and 2012, only a very limited number of wells have actually been drilled. [215] In fact, out of the fifty-six exploratory shale gas wells in the first half of 2013, only twenty-four were productive gas wells.[216]

The location of China's formation necessitates deeper drilling, which is associated with higher costs to survey, develop, and exploit.[217] The valuable shale resources in southwest China are located between 3,000 to 5,000 meters underground.[218] The deeper drilling goes, the "more expensive, noisier and potentially more dangerous" it becomes.[219] Not only are China's shale deposits "significantly transformed" by tectonic movements, but the country's geology also makes collapse and fluid leakage more likely during horizontal drilling.[220] Where U.S. shale deposits are

213. Biello, *supra* note 8.

214. Pu Jun & Huang Kaiqian, *China Shale Gas Goals Pipe Dreams, Experts Say*, MARKET WATCH (Aug. 26, 2013, 11:07 PM), http://marketwatch.com/story/china-shale-gas-goals-pipe-dreams-experts-say-2013-08-26.

215. *See* Wu & Yang, *supra* note 285, at 802 (arguing that the lack of commercial production combined with the limited ability to withdraw capital investments by transferring exploitation rights to other enterprises causes enterprises to risk significant exposure and the economic risks caused by the market withdrawal mechanism affect the commerciality of the enterprises, which in turn extends the time enterprises need to withdraw their capital investment). *Multiple Investment Situation in Shale Gas Exploration Was Formed—Take You Through the Situation of Shale Gas Resource in China*, *supra* note 85.

216. Pu & Huang, *supra* note 214.

217. Adams et al., *supra* note 89, at 573-74; Keith Bradsher, *Natural Gas Production Falls Short in China*, N.Y. TIMES (Aug. 21, 2014), http://nytimes.com/2014/08/22/business/energy-environment/chinas-effort-to-produce-natural-gas-falls-far-short.html.

218. Liu Xiaoli, *Shale Gas Development and Challenges in China*, 95 OXFORD ENERGY F. 10, 10 (2014); In particular, Sichuan's shale gas reservoirs are about 6,600 to 19,700 feet below ground. Lanre Aladeitan & Chisom Nwosu, *Shale Gas Development: Their Gain, Our Pain and the* Cost, 6 J. POL. & L. 216, 217 (2013).

219. Keith Bradsher, *China Takes on Big Risks in Its Push for Shale Gas*, N.Y. TIMES (Apr. 11, 2014), http://www.nytimes.com/2014/04/12/business/international/china-takes-on-big-risks-in-its-push-for-shale-gas.html.

220. SANDALOW ET AL., *supra* note 12, at 13.

usually found in flat surfaces, China "looks like a Texas chainsaw murderer went after that table and cut it into hundreds of pieces."[221] All in all, both well costs and drilling completion times were at least four times higher in China than in the United States.[222]

C. Water

Drilling for shale gas will be particularly costly in China due to the country's water shortage.[223] Shale gas production requires a large amount of water throughout each stage, which raises concerns about water usage.[224] The availability of potable water is already an urgent issue in China: water resources are not well distributed through the country, and the per capita availability of drinking water is very low.[225] Approximately 70 to 140 billion gallons of water are used to fracture 35,000 wells every year in the United States.[226] The amount of water that is needed varies substantially between wells and is influenced by the technology and methods employed, but three million gallons of water is the average requirement to drill and frack one horizontal shale gas well.[227] A deeper well in the United States may use up to six million gallons.[228] U.S. shale gas wells use three to four million gallons of water per well.[229] For example, one single well in the Marcellus Shale formation requires a total volume of 3,880,000 gallons of water per well, which includes 80,000 gallons of drilling

221. Haas, *supra* note 27.

222. Song, *supra* note 73.

223. Watts, *supra* note 81.

224. Sakmar, *supra* note 21, at 379-80, tbl.1. *See also Hydraulic Fracturing 101*, *supra* note 45. (arguing that extracting large amounts of water for fracking "raise[s] concerns about the ecological impacts to aquatic resources, as well as dewatering of drinking water aquifers").

225. Farah & Tremolada, *supra* note 12, at 15; 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., forthcoming 2016).

226. *Hydraulic Fracturing 101*, *supra* note 45.

227. MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES, *supra* note 43, at 64.

228. SANDALOW ET AL., *supra* note 12, at 38.

229. *Id.*

water and 3,800,000 gallons of fracturing water.[230] In Texas, major complaints have been raised in response to such high usage of water, especially in times of drought.[231]

Unfortunately for China, water resources are roughly one-fourth as plentiful as those in the United States.[232] China faces water-related issues, such as water pollution and distribution.[233] Fracking water that is not recovered postproduction could contaminate groundwater.[234] What makes matters worse for China is that water is running short in 500 of China's 700 major cities.[235] Given that China already faces issues with its supply of drinking water, it is likely that water supply issues will be further exacerbated by China's long-term shale gas development goals.[236] In addition, some regions with an abundance of shale have limited water supply relative to its population density.[237] Because shale gas production uses water cyclically, some local communities may be unprepared for large water production demand, especially during times of drought.[238]

In addition, China needs an integrated water resource management system to jointly manage its water use.[239] As noted earlier, the lack of clear demarcations in agency responsibilities creates overlap and friction.[240] Although the National People's

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230. MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES, *supra* note 43, at 64.

231. *Id.* at 9.

232. *Id.*

233. Cann et al., *supra* note 3, at 13.

234. *See* Wang, *supra* note 115 (stating that fracking consumes water, and that the drilling process can put an entire underground aquifer at risk of being contaminated).

235. *Id.*

236. SANDALOW ET AL., *supra* note 12, at 39-40.

237. *See* McMahon, *supra* note 40 (arguing that one reason why fracking has not been as successful in China as in the United States is the water shortage in some populated areas); SANDALOW ET AL., *supra* note 12, at 39.

238. SANDALOW ET AL., *supra* note 12, at 40.

239. *See* Farah & Tremolada, *supra* note 12, at 16 (arguing that administrative coordination increases efficiency and decreases political frictions and information asymmetry); Christin T. Reynolds, *The Status of Integrated Water Resource Management (IWRM) in China: An Investigation of the Songhua River in China*, *in* WORLD ENVIRONMENTAL & WATER RESOURCE CONGRESS 2008: AHUPUA'A (Roger W. Babcock, Jr. et al. eds., 2008), http://cedb.asce.org/CEDBsearch/record.jsp?dockey=165861.

240. *Id.*

Congress and the State Council have enacted water laws and regulations, several ministries and authorities are responsible for managing the actual water supply,[241] while others are responsible for water pollution prevention.[242] Thus, a common expression for describing China's current system is that "nine dragons" manage the water — signifying the agencies charged with regulating various aspects of water management.[243]

Water issues are also compounded by the challenging climatological and geological conditions found in parts of China where rich shale gas basins are located.[244] Water supply constraints could be a factor in some regions in China,[245] particularly where drillers need ten times more water for fracking shale than conventional wells.[246] As a benchmark, one shale gas extraction hole expends more than 10,000 cubic meters of water.[247]

Despite the water-related concerns discussed above, all is not lost. Water management and reuse strategies that have been developed and implemented in the United States, along with improvements and efficiency enhancements in fracking and horizontal drilling technology, may be transferrable.[248] Many shale-rich regions, such as Sichuan, have a large water supply.[249]

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241. *Id.* at 15-16.

242. *See id.* at 15 (explaining that the Ministry of Water Resources provides water resource management and oversees planning, zoning, and monitoring water quality whereas the Ministry of Environmental Protection is in charge of laws, regulations, and standards regarding water pollution and the enforcement of water quality).

243. The nine "dragons" are the MEP, MLR, NDRC, MOF, Ministry of Water Resources (MWR), Ministry of Housing and Urban and Rural Construction, Ministry of Agriculture, State Forest Administration, and Ministry of Transportation State Oceanic. Farah & Tremolada, *supra* note 12, at 15-16 & n.52. Even though MWR is the leading agency responsible for integrated water resource management tasks, MEP is responsible for water pollution laws, regulations, and standards supervision and enforcement. *Id.* at 15.

244. *See* SANDALOW ET AL., *supra* note 12, at 8 (concluding that some shale-rich regions have very limited water resources and that droughts could create challenges for shale gas production).

245. *Id.* at 38.

246. Wang, *supra* note 115.

247. *Id.*

248. AM. PETRO. INST., *supra* note 96, at 14.

249. SANDALOW ET AL., *supra* note 12, at 39.

For example, ninety percent of the fourteen million barrels of fluids was reused in the first half of 2013 at the Marcellus Shale play.[250] Commercial drillers should first identify water supply capable of meeting the needs of its fracking activities without interfering with adjacent community needs.[251] Given that China already faces a water shortage, recycling water for hydraulic operations is a pivotal consideration.[252] China might be able to apply U.S. technology to its domestic front and find a sustainable way to use water.[253]

D. Infrastructure

Although China has an excellent track record of building infrastructure almost overnight, China would need to invest more than $500 billion USD to build a pipeline system comparable to that in the United States.[254] In contrast to the United States, China does not have existing shale gas pipeline networks to move the gas to power plants, homes, and factories.[255] In addition, transporting natural gas to market requires infrastructure and a respective legal framework.[256] To rectify this problem, CNPC has announced goals to construct China's first shale gas pipeline, but it naturally will take some time to develop.[257] However, as just mentioned, building such a network in China may cost upwards

250. *Id.*

251. *See* MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES, *supra* note 43, at 66 (discussing the water supplies needed in the United States to drill and stimulate shale gas wells, and the importance of not interfering with community needs).

252. *See* SANDALOW ET AL., *supra* note 12, at 37-38 (stating that China faces substantial challenges in managing its water supplies, and that recycling can reduce the overall water use).

253. Antonia Sohns, *What China and Other Nations Can Learn from U.S. Shale Gas Fracking Experience*, POWER (June 23, 2014), http://www.powermag.com/blog/what-china-and-other-nations-can-learn-from-u-s-shale-gas-fracking-experience/?printmode=1 (arguing that best practices from the U.S. experience, such as produced water recycling should be available to other countries developing shale gas).

254. Biello, *supra* note 8.

255. Stevens, *supra* note 20, at tbl.1; Haas, *supra* note 27.

256. *See* Biello, *supra* note 8 ("Getting that world-changing gas . . . requires the infrastructural support — and legal framework — to get that gas to market and reward those who produce it.").

257. SANDALOW ET AL., *supra* note 12, at 29.

of half a trillion dollars.[258] The combination of these issues discussed above has proven to be a major barrier to systematic development.[259] In addition, CNPC has pipeline construction and operation monopolies, which may arguably slow development.[260] Currently, Chinese regulation of natural gas prices disincentivizes financial investment to build natural gas infrastructure, which is usually an up-front sunk cost.[261] Most importantly, investments that are made now will not mature for many years, which disincentivizes new entrants from investing capital into shale gas projects.[262]

Natural gas projects in western and northern China, where the largest natural gas reserves are located, have compelled the Chinese government to add pipeline infrastructure.[263] The target is to construct 100,000 kilometers of pipeline by the end of 2015.[264] Furthermore, the Chinese government should regulate the pipeline network, perhaps even force the major pipeline administrators — PetroChina and Sinopec — to transport third party shale gas in order to break up the present gas pipeline monopoly.[265] Although the Sichuan basin has a network of gas pipelines, some of China's other shale gas resources, such as the Tarim basin in the northwest, are located in inaccessible areas.[266] China lacks the infrastructure to deliver natural gas to these remote areas.[267] Access to these regions is not only problematic, but it will also result in bottlenecks in natural gas

258. *Id.*

259. Adams et al., *supra* note 89, at 574; *see* Farah & Tremolada, *supra* note 12, at 35 (noting that requirement that companies share profits with the government or government companies deters investors from shale gas exploration and production).

260. NAKANO ET. AL., *supra* note 70, at 19.

261. Lei Tian et al., *Stimulating Shale Gas Development in China: A Comparison with the US Experience*, 75 ENERGY POL'Y 110, 114 (2014) (stating that deregulation will provide a stronger incentive to invest in shale gas and infrastructure).

262. *Id.* at 114-15.

263. Wang & Li, *supra* note 61, at 186.

264. Zeng et al., *supra* note 62.

265. *Id.*

266. Gunningham, *supra* note 37, at 307.

267. *See id.* (stating as an example that the remote and sparsely populated Tarim Basin lacks even the basic infrastructure for producing or transporting gas).

transmission.[268] Extension of existing pipelines into these remote areas would require considerable time and cost.[269]

VII. OPPORTUNITIES

Despite these challenges discussed above, all is not lost. First, because hydrocarbon resources are owned wholly by the Chinese government, not only is the government in charge of overseeing the responsible stewardship of the environment, similar to the U.S. EPA, but it is also in charge of deciding who can engage in oil and gas exploration and production, where they can engage in such activities, and at what price. In addition, administrative agencies bear the responsibility of implementing environmental laws.[270] For example, the Ministry of Environmental Protection plays a fundamental role in shale gas production;[271] it has jurisdiction to amend a number of rules and regulations, including the Environmental Protection Law, Law on Evaluation of Environmental Effects, Water Law, and Air Pollution Prevention and Control Law of China, and can punish individuals and corporations for violating environmental laws and regulations.[272] This ability to control its resources enables the Chinese government a to implement strict guidelines on producing shale gas sustainably.

Furthermore, although PetroChina and Sinopec are still dominant players in China's domestic shale gas,[273] the government has made shale gas an "independent mineral" in

268. *Id.*

269. *Id.*

270. Farah & Tremolada, *supra* note 12, at 18-19 (discussing the various agencies and their subsidiaries which implement and enforce the environmental laws). The Ministry of Land and Resources oversees the bidding process for shale blocks and issues permits to the company with the winning bid, and the National Development and Reform Commission regulates China's oil and gas extraction. Furthermore, the Chinese government formed the National Energy Administration in 2008 to approve and regulate new energy projects, including setting energy prices and implementing policies. *See* Chou, *supra* note 132, at 7; CHINA: OVERVIEW, *supra* note 2, at 4.

271. Farah & Tremolada, *supra* note 12, at 18-19.

272. Chou, *supra* note 132, at 7; Lin Mingche et al., *Shale Gas Development Calls for Changes in the Regulatory Regime*, CAIXIN ONLINE (Nov. 7, 2012, 9:58 PM), http://caixin.com/2012-11-07/100457055.html.

273. Chou, *supra* note 132, at 2.

order to alleviate the monopolistic control of the national oil companies.[274] A notable example of this de-monopolization can be seen via Notice 159, which allowed foreign companies to participate in China's shale gas industry by partnering up with Chinese corporations.[275]

Lastly, the nature of shale gas development and exploration incentivizes foreign investment. Unlike conventional gas production, the nature of shale gas exploration requires ongoing development, and thus a steady flow of capital.[276] In other words, one can argue that because technology and investments are needed throughout the process, foreign investors have an incentive to invest in shale gas projects because of the continuous nature of the investment.

Despite China's desire to emulate U.S. shale gas production, China is failing to meet its production targets set out in the shale gas plans described above.[277] These goals are "potentially within China's reach," if adversity is overcome.[278] Needless to say, the current effort to "knockoff America's oil and gas fracking boom" has thus far been unsuccessful.[279] However, China's efforts have not all been in vain: it produced 200 mcm of natural gas from shale formations in 2013, nearly seven times the amount produced in the previous year.[280] Although there is room for growth, the ability to accelerate this process is uncertain. It took China three years to add environmental standards to its law books, and drafting rules to regulate the environmental aspects of fracking could take an additional three to five years by one

274. Xiaoli, *supra* note 218; Zeng et al., *supra* note 62; CHEN ET AL., *supra* note 182.

275. MINISTRY OF LAND AND RESOURCES OF THE PEOPLE'S REPUBLIC OF CHINA, *Notice on Strengthening the Exploration and Exploitation of Shale Gas and Relevant Supervision and Administration Work*, http://www.mlr.gov.cn/zwgk/zytz/201211/t20121122_1158928.htm

276. Lutz Kilian, *How the Shale Oil Revolution Has Affected U.S. Oil and Gasoline Prices*, VOX (Jan. 14, 2015), http://voxeu.org/article/shale-oil-and-gasoline-prices.

277. *See* Haas, *supra* note 27 (noting that "China's had a bit more success in recent years, but they won't hit the pretty paltry target").

278. *Id.*

279. Chriss W. Street, *China's National Effort in Oil and Gas Fracking Fails*, BREITBART (Aug. 18, 2014), http://breitbart.com/Big-Peace/2014/08/18/China-s-National-Effort-in-Oil-Gas-Fracking-Fails.

280. Biello, *supra* note 8.

estimate.[281] While it may one day enjoy success with shale gas, China will have to forge its own path to get there.

A. Can the United States' Oil and Gas Industry Serve as a Model for China?

Together, China and North America will account for approximately 85% of global shale gas production by 2035.[282] Although China's domestic natural gas production has increased steadily, it still cannot meet the rapid growth of its domestic energy demands.[283] However, because China aspires to decrease its reliance on foreign imports[284] and reduce GHG emissions,[285] China needs to accelerate energy production and find a domestic resource, such as shale gas, to keep up with its energy demands.[286] Chinese shale gas development has evolved under different conditions than the United States' own shale gas revolution and thus provides different technological challenges and risks.[287] Unless China wants to continue depending on high-cost energy imports, the country will need to continue developing its shale gas industry.[288]

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281. Wang, *supra* note 115.

282. *Id.*

283. Yang & Liu, *supra* note 9, at 17.

284. *See* Daly, *supra* note 178 (noting China's interest in developing domestic natural gas reserves in an effort to reduce dependence on oil and coal imports that have proved unstable and unpredictable).

285. Wu Yunna & Yang Yisheng, *The Competition Situation Analysis of Shale Gas Industry in China: Applying Porter's Five Forces and Scenario Model*, 40 RENEWABLE & SUSTAINABLE ENERGY REVS. 798, 801 (2014) (noting China's desire to curb the burning of fossil fuels in light of concerns over air pollution); Yu, *supra* note 25, at 30 (examining China's desire to quickly reduce GHG emissions through the quick adaptation of shale gas technology).

286. Yu, *supra* note 25, at 30.

287. *See* Gunningham, *supra* note 37, at 306 (arguing that China's shale gas is deposited much deeper than those in the United States, increasing the technological difficulty of extraction and heightening the risk of pollution incidents. Clay deposits that are mixed with the shale formation make it harder to fracture the shale compared to U.S. shale formations that are instead mixed with quartz. The mountainous, rocky terrain of the shale-rich regions also confounds the technical, geological, and transportation challenges).

288. *See id.* (arguing that if China continues to rely on high-cost energy imports, it "seems doomed to continue to destroy its industrial competitiveness").

How can the United States' oil and gas industry serve as a model for China? First, although the United States' experience may be a success story, simply applying what worked in the United States to China may not help China meet its shale production goals. The development of shale gas resources in the United States has not been without its share of environmental trepidations and public health concerns.[289] The United States has had a long history of oil and gas production and, in that time, has seen many successes and failures. The evolution of the industry has spurred innovation and enterprise as private companies invested millions in new technologies and techniques for retrieving hydrocarbons. Unsurprisingly, as the industry developed, so too did the regulatory regime in which the industry operated.

Lastly, although China has shale gas resource potential, there are challenges and opportunities that must be addressed first.[290] Although there are similarities between the Chinese and American energy industries, China's current legal framework may impede its ability to successfully expand the shale gas industry.[291] Although the decrease of conventional energy sources, coupled with new drilling technologies, has resulted in calls for legislative changes in the Chinese regulatory framework,[292] China needs to keep in mind that, although the legal system in the United States has enabled drillers to innovate and reap the rewards from horizontal drilling and hydraulic fracturing, the system is not without flaws.[293]

Indeed, the U.S. shale gas revolution was the culmination of many country-specific factors, including actions by individual entrepreneurs and private sector investments by oil and gas companies willing to take a risk for the chance at a substantial

289. *See* Bernard D. Goldstein et al., *Challenges of Unconventional Shale Gas Development: So What's the Rush?*, 27 NOTRE DAME J.L. ETHICS & PUB. POL'Y 149, 157-61, 184 (2013) (describing the health and environmental concerns surrounding the use of unconventional shale gas such as air and water pollution, the health of workers, radiation, and toxicological problems of chemical mixtures).

290. Zeng et al., *supra* note 62.

291. Farah & Tremolada, *supra* note 12, at 29; Zeng et al., *supra* note 62.

292. Deemer, *supra* note 211, at 9.

293. *See* McMahon, *supra* note 40 (explaining that the regulatory framework in the United States allows drillers to experiment with unconventional development).

profit.[294] It may very well be that China's overall energy framework is too different for China to completely emulate the United States' success. In fact, the route China will need to take in order to successfully produce shale will be very different from that of the United States. The U.S. shale gas revolution was the result of legal and environmental factors that cannot be easily transferred to China. For one, the U.S. regulatory framework encouraged drillers to experiment with fracking.[295] In the United States, there are at least 6,000 companies engaged in exploration and production of oil and gas.[296] In addition, U.S. landowners have the right to lease out mineral rights to their property, a right that Chinese landowners do not possess.[297] Because oil and gas is state-owned, Chinese individuals and small independent companies are less competitive than state-owned enterprises.[298] Although one may argue that China should also address property rights to incentivize private companies to develop shale, the flipside of the lack of private ownership is that the government can make decisions without having to balance private ownership rights.

This flipside is the most important issue: as China plans its energy future, the country is in the unique position to learn from U.S. mistakes and develop its shale resources responsibly. Current studies mainly focus on the challenges instead of the opportunities. A plethora of studies comparing the shale gas industry in China and the United States focuses on geological evaluation and exploration techniques,[299] but the studies fail to examine the difference in property ownership laws and the opportunities presented. The Chinese government can take advantage of this major difference and choose to develop its shale gas responsibly without having to balance private property interests. For these reasons, the U.S. framework should serve

294. Downie & Drahos, *supra* note 16, at 6; SANDALOW ET AL., *supra* note 12, at 33.

295. McMahon, *supra* note 40.

296. MARTIN S. RAYMOND & WILLIAM L. LEFFLER, OIL AND GAS PRODUCTION IN NONTECHNICAL LANGUAGE 223 (2006).

297. McMahon, *supra* note 40.

298. *See* SANDALOW ET AL., *supra* note 12, at 33 (arguing that potential shale gas entrepreneurs in China face, among other problems, difficulties gaining access to good acreage and pipelines).

299. Yu, *supra* note 25, at 31.

merely as a guide. China needs to formulate its own shale gas regulatory framework by learning from the positives and negatives of the United States' experience.

VIII. CONCLUSION

Despite its challenges, Chinese authorities will have an opportunity to choose to continue to move forward with fracking without hesitation in light of potential environmental concerns, or they can learn from United States' mistakes and develop its shale resources responsibly.[300] Although the Chinese government can be said to have adopted a mentality that has been described as "pollute first, clean up later,"[301] or "pollute first, control later,"[302] China is in an advantageous position because its minerals are state-owned. Thus, the government can develop its own policies without pushback from private landowners like in the United States. Specifically, these policies should be able to deter the tragedy of the commons problem and eliminate harmful drilling practices commonly seen in the United States.

300. Daly, *supra* note 178.

301. Jaeah Lee & James West, *The Great Frack Forward*, MOTHER JONES (Sept. 18, 2014, 6:00 AM), http://motherjones.com/environment/2014/09/china-us-fracking-shale-gas (last visited Jan. 13, 2016).

302. Wang, *supra* note 7, at 198.