Environmental Science & Technology

Viewpoint

pubs.acs.org/est

Emerging Shale Gas Revolution in China

Yunhua Chang,[†,§,∥] Xuejun Liu,*[,‡] and Peter Christie[‡,⊥]

[†]State Key Laboratory of Desert and Oasis Ecology, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China

[‡]College of Resources and Environmental Sciences, China Agricultural University, Beijing 100193, China

[§]Graduate University of the Chinese Academy of Sciences, Beijing 100049, China

[∥]College of Geography and Environmental Science, Northwest Normal University, Lanzhou 730070, China

[⊥]Agri-Environment Branch, Agri-Food and Biosciences Institute, Belfast BT9 5PX, U.K.

Hydraulic fracturing to recover shale gas has been practiced in North America for many years but over the last decade the US has witnessed rapid development of new technology allowing the widespread recovery of natural gas from shale formations and this has revolutionized the energy sector there. The US therefore has a world lead in 'fracking' techniques and also research on the potential adverse environmental consequences of this technology. China is now embarking upon substantial development of shale gas extraction but the question of major public concern is whether or not the Chinese government will try to learn from the US experience not only to benefit from the new engineering techniques but also to minimize the negative impacts of this technology on environmental and human health. Poorly regulated industrialization has already led to environmental pollution on a massive scale in China.

A study by the Chinese Ministry of Land and Resources estimates that China has the largest proven reserves of shale gas worldwide—25.08 trillion cubic meters (cu m) totally—nearly 200 times its annual gas consumption. Indeed, the exploitation of this natural gas reserve could reduce China's reliance on coal as well as foreign oil or liquefied natural gas (LNG) imports, and also dramatically reduce the country's CO_2 emissions, thus accelerating China's transition to a resource-conserving and environmentally-friendly society. Although China is in the nascent stage of shale gas development, it has set an ambitious goal of 6.5 billion cu m of shale gas production by 2015 as part of the 12th Five-Year Plan (2011−2015). This is equivalent to 2−3% of projected 2015 Chinese gas production, with over 60 billion cu m of shale gas production planned by 2020.

As a near-term energy strategy, there are three key areas—technical expertise, infrastructure construction, and pricing systems—in which China might be able to gain from U.S. experience. So far, China's drilling practices are still at the research stage and the pipeline system is small and fragmented (Figure 1). Government control of natural gas resources and interference in the pricing system make domestic gas uncompetitive with coal and crude oil. However, during the visit of U.S. president Barack Obama to China in 2009, the government signed a Shale Gas Initiative on joint technical studies to accelerate the development of shale gas resources in China.

Moreover, China plans to expand its gas pipeline network to 62 100 miles by 2015. Energy is needed, but shale gas can be a double-edged sword for China. The Chinese government needs to examine closely the lessons from the hydraulic fracturing debate in the U.S. The entire shale gas development process—from exploration to production and transportation—has been criticized for its negative impacts on water resources, climate change, air quality and human health. More data have recently emerged in North America: (i) fracturing requires tens of million liters of water; and the threat of associated damage such as water pollution and earthquakes has become clearer;[1] (ii) using Life Cycle Assessment, leakage of methane gas from the fracking process has been estimated to form a greater carbon footprint than coal or conventional natural gas in some studies;[2,3] (iii) shale gas extraction has negatively affected local air quality in some regions as a result of the release of nitrogen oxides (NO_x) and volatile organic compounds (VOCs), two air pollutants with significant respiratory and cardiac health effects.[4] Most of China's shale gas reserves reside in Sichuan and Tarim (Xinjiang) basins in the southwestern and northwestern China (Figure 1). Unfortunately, Sichuan is densely populated and this may pose severe safety concerns and challenging engineering conditions.[5] Moreover, the Yangtze River flows through Sichuan Province and might play a significant role in transferring "slick water"—a mixture of water,

Received: October 8, 2012
Revised: October 22, 2012
Accepted: October 25, 2012
Published: November 2, 2012

   dx.doi.org/10.1021/es3040939 | Environ. Sci. Technol. 2012, 46, 12281−12282

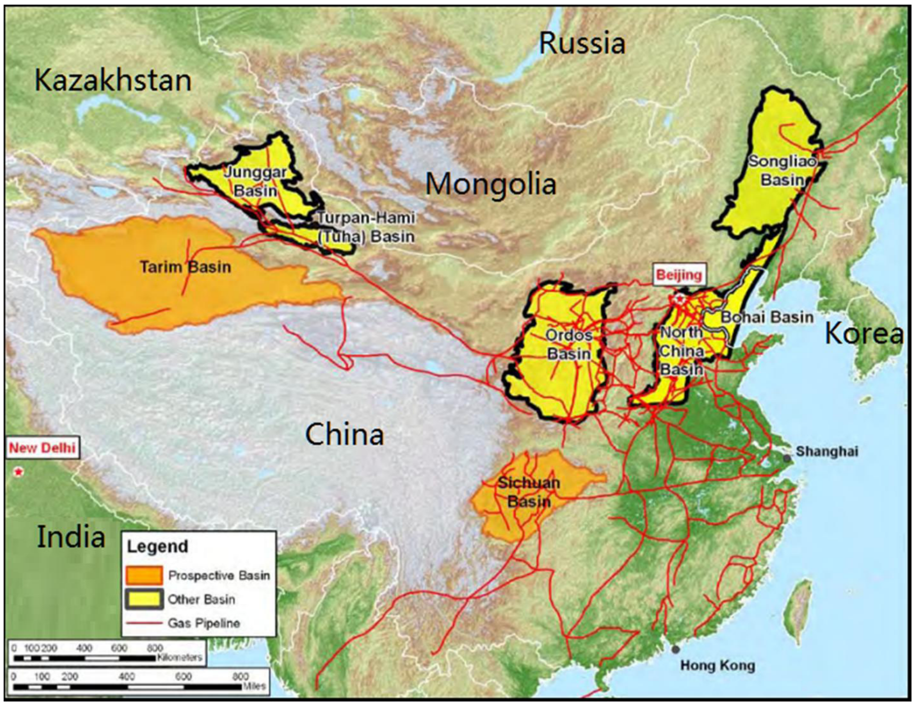

Figure 1. Key shale basins and natural gas pipeline system in China. Image adapted from http://www.eia.gov/analysis/studies/worldshalegas/pdf/fullreport.pdf.

sand and chemicals—from the land to downstream regions. The Tarim basin's unstable geological features and distance from China's main centers of consumption make its economic prospects relatively poor.[5] Furthermore, growing fracking wells could exacerbate the water crisis in this extreme arid zone. It is worth noting that uncertainties and contradictions still exist in current research, and several countries such as France and the UK have shown a cautious approach to shale gas development. We are alarmed that China's recent shale gas development blueprint makes no reference to targets to mitigate the environmental and social impacts of shale drilling.

China's energy demand will continue to increase in the foreseeable future. Shale gas will make a contribution in the medium term but over the long-term the best strategy is to scale up research, development and deployment of renewable energy as the main substitute for fossil fuels. We can only hope that shale gas technology can be developed in a relatively harmless way, but China's recent track record of severe environmental pollution from conventional industries, intensive agriculture and growing energy consumption will lead to continuing public alarm over the development of its extensive shale gas resources.

AUTHOR INFORMATION

Corresponding Author

*Phone: 0086-991-7885367; fax: 0086-10-62731016; e-mail: liu310@cau.edu.cn.

Notes

The authors declare no competing financial interest.

ACKNOWLEDGMENTS

This work was funded by the 'Hundred Talents Program' of the Chinese Academy of Sciences.

REFERENCES

(1) Gregory, K. B.; Vidic, R. D.; Dzombak, D. A. Water management challenges associated with the production of shale gas by hydraulic fracturing. *Elements* **2011**, 7 (3), 181−186.

(2) Howarth, R. W.; Santoro, R.; Ingraffea, A. Methane and the greenhouse-gas footprint of natural gas from shale formations. *Clim. Change* **2011**, *106* (4), 679−690.

(3) Weber, C. L.; Clavin, C. Life cycle carbon footprint of shale gas: Review of evidence and implications. *Environ. Sci. Technol.* **2012**, *46* (11), 5688−5695.

(4) Schmidt, C. W. Blind rush? Shale gas boom proceeds amid human health questions. *Environ. Health Perspect.* **2011**, *119* (8), a348−a353.

(5) Zou, C.; Dong, D.; Wang, S.; Li, J.; Li, X.; Wang, Y.; Li, D.; Cheng, K. Geological characteristics and resource potential of shale gas in China. *Pet. Explor. Dev.* **2010**, 37 (6), 641−653.