1. BACKGROUND

A. The Resource

China has a huge shale gas resource. According to some estimates, it is the world's largest. U.S. EIA estimates that China possesses 31.6 trillion cubic meters (1,115 trillion cubic feet) of technically recoverable shale gas resources. The Ministry of Land and Resources (MLR) puts the figure at 25.1 trillion cubic meters (886 trillion cubic feet).[1]

The geology of China's shale resource is complex. According to the National Energy Administration, China's shale deposits have been "significantly transformed" by tectonic movements. NEA also reports that "complex geological conditions make collapses and fluid leakages more likely in the process of horizontal drilling" and that roughly a third of China's shale resource is lacustrine or transitional-lacustrine[2] — a type of shale from which natural gas is not currently being produced in the United States.

Many of China's largest shale deposits are located in relatively mountainous regions. Partly as a result, Chinese shale resources are generally much deeper than those in the United States.[3] The mountainous terrain can create siting challenges, since drilling operations require adequate space and road access. Sichuan and Chongqing — home to some of China's richest shale resources — have high population densities compared to U.S. oil and gas regions. All of these factors potentially add expense to Chinese drilling operations.

B. The Industry

China's natural gas industry has grown rapidly in recent years. Between 2003 and 2012, China's natural gas production more than tripled to reach 108 billion cubic meters per year (10.4 billion cubic feet per day). During the same period, consumption more than quadrupled, reaching almost 161 billion cubic meters per year (15.5 billion cubic feet per day).[4]

Yet natural gas is still a small portion of the Chinese energy mix. In 2012, the fuel accounted for roughly 5 percent of China's primary energy consumption.[5] In

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[1] U.S. Energy Information Agency (EIA), Technically Recoverable Shale Oil and Shale Gas Resources (June 2013) at table 6, http://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf; Ministry of Land and Resources (MLR), National Survey and Assessment of Shale Gas Resource Potential 2013, http://www.mlr.gov.cn/xwdt/jrxw/201203/t20120302_1069466.htm. Chinese figure excludes Tibet and and Qinghai.

[2] Presentation of Xiaolong Li, NEA at Houston USTDA Conference (July 1, 2014)

[3] See Ella Chou, "Shale Gas in China — Development and Challenges" (July 11, 2013) at p. 8, http://blogs.law.harvard.edu/ellachou/files/2013/07/Shale-Gas-in-China-Draft.pdf.

[4] U.S. EIA, "Natural Gas Serves a Small, But Growing, Portion of China's Total Energy Demand," Today in Energy, August 18, 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=17591&src=email

[5] Ibid.

Comparison, gas represented 20% of the primary energy consumption in Asian countries excluding China.[6]

The role for natural gas is even smaller as a source of China's power generation. In 2012, gas comprised only 2 percent of China's power generation, far below the global average.[7] To alleviate air pollution caused by heavy coal consumption, the Chinese government hopes to significantly increase the share of natural gas in the power sector.[8]

In addition to power generation, natural gas is used in China for industry, buildings, transportation and other purposes. Leading authorities provide somewhat different breakdowns. In our research, we found estimates for power generation ranging from 17 to 20% of total natural gas use in China, estimates for industrial use ranging from 36 to 43%, estimates for residential/building use ranging from 18 to 25% and estimates for transportation use ranging from 4 to 13%.[9]

China is turning to diverse sources of supply for natural gas. The government's 2015 domestic production target is roughly 5.5 Tcf per year, with substantial production growth planned for the north, west and South China Sea. In addition, China is becoming one of the world's largest importers of LNG (with 10 regasification terminals). Over the past few years, China has also ramped up imports of natural gas through pipelines from Central Asia (Turkmenistan, Uzbekistan and Kazakhstan) and Myanmar. In 2014, China signed a $400 billion agreement with Russia for natural gas to be transported through a new pipeline starting in 2018.[10]

In China, three vertically-integrated national oil companies (NOCs) — CNPC, Sinopec and CNOOC — control much of the natural gas industry. In 2011, CNPC, Sinopec and CNOOC respectively represented 71 percent, 12 percent and 15 percent of natural gas production in China.[11] PetroChina, a subsidiary of CNPC, controls 80 to 90% of the trunk natural gas pipelines in China. (China has roughly 40,000 kilometers of natural gas pipelines — roughly 10% of that in the United States.) These NOCs dominate not just upstream production and pipelines, but also the oil and gas service sector. As a result of their size and scope, the NOCs have the capacity to cover financial losses in one sector, with profits from another. The relationships between the NOCs and central government can be complex: the companies operate independently yet their senior executives are

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[6] Michael Farina and Adam Wang, China's Age of Gas (GE 2013), p.10, http://www.ge.com/cn/sites/default/files/GE-Gas-China-1015final.pdf.
[7] Ibid.
[8] NDRC; "12th Five Year Plan on Natural Gas Development," p. 1, http://www.gov.cn/zwgk/2012-12/03/content_2280785.htm
[9] Farina and Wang, China's Age of Gas, p. 7, at note 8; China Energy Fund Committee, China Energy Focus Natural Gas 2013, pp. 23–24, http://csis.org/files/publication/131212_CEFC_China_Energy_Focus_Natural_Gas.pdf.
[10] U.S. EIA, "Natural gas," at note 6.
[11] Lei Tian et al., Stimulating Shale Gas Development, at note 1.

appointed by the central government and often return to the government after serving at the NOCs.[12]

Oil and gas mineral rights in China are owned by the state and managed by the central government. Land use rights and rights to other minerals are sometimes held at the local level. At times, separation of land and mineral rights has led to conflicting interests between government entities. For example, when developing coal-bed methane (CBM), the central government holds the rights to natural gas (CBM in this case) and the local government has rights to the coal mines.[13] As a result, the rights to CBM and coal within a single field can be assigned to two different companies.

Historically, natural gas mineral rights are granted to the major NOCs through a "first come, first served" application process.[14] In recent years, mineral rights for unconventional natural gas have been opened up to the market more broadly. Qualified shale gas developers can participate in auctions for mineral exploration rights.[15] However, nearly 80 percent of China's shale gas resource overlaps with conventional oil and gas reserves held by the NOCs. In November 2012, the Ministry of Land and Resources published a notice giving NOCs priority in exploring for shale gas in overlapping areas.[16] In the notice, MLR indicates that if an owner of an overlapping block does not put enough effort into exploring shale gas, it could be required to transfer rights to other investors.[17]

C. Shale Gas Production to Date

Shale gas production in China is just starting. According to NEA, 184 wells have been drilled as of May 2014, resulting in daily production of 134 million cubic feet (1.4 bcm/year).[18] In the United States, in contrast, roughly 100,000 wells have been drilled, resulting in daily production of over 31 bcf (323 bcm/year).[19]

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[12] Ibid., p. 10.
[13] U.S. EIA, China, p. 21, http://www.eia.gov/countries/analysisbriefs/China/china.pdf (last updated: February 4, 2014).
[14] Presentation by Huabin Wang, "Governmental Management on Oil and Gas Exploration and Mining in China," pp. 7–8, Department of Geological Exploration, MLR, July 1, 2014.
[15] Presentation of Xiaolong Li, NEA at Houston USTDA Conference (July 1, 2014)
[16] MLR, "Notice with Regard to Reinforcing Exploration of Shale Gas Resources and Supervising Work Management," October 2012, http://www.mlr.gov.cn/zwgk/zytz/201211/t20121122_1158928.htm.
[17] Ibid.
[18] Presentation of Xiaolong Li, NEA at Houston USTDA Conference (July 1, 2014)
[19] On number of wells drilled, see BakerHughes Well Count at http://phx.corporate-ir.net/phoenix.zhtml?c=79687&p=irol-wellcountus; American Petroleum Institute, "Investment in U.S. shale well drilling surges in 2011" (April 29, 2013), http://www.api.org/news-and-media/news/newsitems/2013/april-2013/investment-in-us-shale-well-drilling-surges-in-2011; Matt Kelso, "Over 1.1 Million Active Oil and Gas Wells in the US," (March 4, 2014), http://www.fractracker.org/2014/03/1-million-wells. On daily production, see Adam Sieminski, http://www.eia.gov/pressroom/presentations/sieminski_01222014.pdf, p. 4 (US shale gas production at end of 2013 was roughly 31 billion cubic feet per day)(confirmed in personal communication with author from EIA staff). See also Darren Barbee, "The Great Shale Wall" (December 21, 2013), http://www.ugcenter.com/International-Shales/The-Great-Shale-Wall-China-Struggles-Emulate-US-Success_127423 (quoting Jason Bordoff, Director of Columbia Center on Global

Most shale gas drilling to date has been in Sichuan and Chongqing. The most successful project to date has been Sinopec's Fuling project near Chongqing — the only project to achieve production on a commercial scale. Sinopec reports that it is producing 600 million cubic meters per year of shale gas at Fuling and expects to produce 10 billion cubic meters (bcm) per year at the project by 2017.[20] (In our interviews, we heard rumors that some of the production at Fuling is not from shale rock. Sinopec strongly denies such claims.)[21]

China is making progress in developing a supply chain for shale gas production. According to NEA, 3,000 fracturing vehicles have been put into field operation. Equipment that includes open hole packers, frac plugs and other downhole fracturing tools have been developed, with some now being exported to the North American market. NEA says that China has "gained experiences in horizontal drilling, well completion, and large-volume fracturing technologies."[22]

However shale gas drilling costs have been high. One expert we spoke with estimated that drilling time at Chinese sites average 250 days, as compared to 10 to 20 days at many U.S. shale plays.[23] According to one estimate, Sinopec and CNPC's short-term losses from shale gas drilling through the end of 2013 are close to $1 billion. [24]

Foreign firms are playing an important role in Chinese shale gas production. On March 20, 2012, Shell announced that it signed a production-sharing contract (PSC) with CNPC to explore, develop and produce shale gas in the Fushun-Yongchuan block (~3,500 square kilometers) in the Sichuan Basin. This is the first shale gas PSC in China. Progress at this site has reportedly been slow, in part due to "spontaneous village-based blockades." Shell has reportedly adjusted its investment strategy in China's shale gas sector.[25]

Other IOCs — including Chevron, Conoco Philips, Exxon and Hess — are also cooperating with CNPC or Sinopec on shale gas, mostly through joint study agreements (JSA). (See Attachment B for a list of such agreements based on public announcements, securities filings and media reports.) The extent of progress under those agreements is unclear. In its 2013 SEC 10-K filings, Chevron stated that two exploratory shale gas wells were unsuccessful.

Energy Policy, "If it's the second or third inning in the U.S. shale revolution, it's like batting practice in China").

[20] "Sinopec Makes Breakthrough in Shale Gas (March 25, 2014), http://www.chinadaily.com.cn/business/2014-03/25/content_17377038.htm; "Sinopec's Fuling Shale Gas Project to Hit 10 Bcm/year by end 2017," Platts, 24 March 2014.

[21] See "Sinopec Shale Gas — Is It True?" Sina Finance (June 20, 2014), http://finance.sina.com.cn/zl/energy/20140620/082619471212.shtml (Sinopec denies rumors that production at Fuling is not shale gas).

[22] Presentation of Xiaolong Li at note 4.

[23] Author interview.

[24] Lei Tian et al., Stimulating Shale Gas Development, p. 4, at note 1.

[25] Shell, "Sinopec and Shell Signed the First Shale Gas PSC in China" (March 20, 2012), -- http://www.shell.com.cn/zh/aboutshell/media-centre/news-and-media-releases/archive/2012/cnpc-shell-sign-first-shale-gas-production-sharing-contract-20120312.html; "IOCs are Having Difficulties Developing Shale gas; Shell Shifting to other Assets" (March 31, 2014), NBC, -- http://www.yicai.com/news/2014/03/3650668.html; Telegraph, "Shell shuts down 8.3 billion projects in China", -- http://www.telegraph.co.uk/finance/newsbysector/energy/oilandgas/10300263/Shell-shuts-down-8.3bn-project-in-China.html