Shale Gas Development in China

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On the Brink of Yeyanqi Revolution: Shale Gas Development in China

An Overview of the Energy Sector

It is no revelation that China has looked to diversify its energy supply in recent years. China, an energy-hungry behemoth, experienced energy consumption growth of 136 percent between 2001 and 2011 (Economist Intelligence Unit, 2012a). Beijing's expansive energy needs are attributed to an average real growth domestic product of 10.5 percent a year from 2007 to 2011 (Economist Intelligence Unit, 2012b). Its energy basket is now predominantly based on fossil fuels, and 66 percent of China gross domestic energy consumption was provided by "dirty" coal in 2011 (Economist Intelligence Unit, 2012a). China's 12th five year plan (2011-15) set the target of increasing energy efficiency by 16 per cent (Economist Intelligence Unit, 2012a), and reducing carbon dioxide emissions by 17 percent per unit of gross domestic product over the five-year period (KMPG China, 2011). Beijing, however, is having difficulties with meeting these ambitious goals – in 2011, energy intensity was only decreased by 2 percent in comparison with the 3.5 percent target set in the five year plan (Economist Intelligence Unit, 2012a).

Beijing's current priority, as Yongru Chaeng, a Chinese party official affiliated with the Ministry of Commerce, stated, is to upgrade the economy and to increase the efficiency [of the energy sector] and to diversify energy components (Chaeng, 2012). China is pushing to increase the share of non-fossil fuels to 11.4 percent in 2015 and 15 percent by 2020 (KMPG China, 2011). It is considering capping total energy use at either 4.1 or 4.2 billion tons of coal equivalent by 2015 (KMPG China, 2011). China's long-term plan is to cut carbon intensity by 40 to 45 percent by 2020, relative to 2005 levels (KMPG China, 2011). In order to meet its ambitious goals, Beijing has been investing in natural gas and renewable energy sectors. Coal's contentious nature, related high carbon emissions and consequent environmental pollution are making the development of natural gas and renewables vital for China. Policy-makers and regulators are now trying to stimulate the development of these industries in order to displace coal in electricity generation across the country (KMPG China, 2011).

China on the Brink of a Shale Gas Revolution

Wen Jiabao, China's premier, had first mentioned shale gas or *yeyanqi* in his annual work report in 2012 (Hook, 2012b). The development of shale gas is a priority for the Chinese leadership, who hope that the resource will decrease reliance on foreign imports and allow for greater independence and security (Shaofeng & Qiang, 2012; Hook, 2012b). Beijing underlines the importance of natural gas in meeting energy needs and decreasing carbon dioxide emissions (Shaofeng & Qiang, 2012; Hook, 2012b). The US Energy Information Administration estimated that the Chinese recoverable shale gas reserves are at 36.1 trillion cubic meters (US Energy Information Administration, 2012), while the most current estimate by the Chinese Ministry of Land and Resources is at 25.1 trillion cubic meters (Hook, 2012a) – making China the country with the largest shale gas reserves in the world and greatest potential for development.

Shale Gas Extraction: Technology, Concerns and Consequences

Shale gas, or natural gas, deposited within shale rock formations (Stevens, 2010) had been extracted since 1825

(Kefferputz, 2010), however, its extraction was not economically viable until recently. Shale rock formations are very low in permeability and porosity, and shale gas is characterized by "lack of spontaneous flow of gas to a drilled well" (Lesniewics, 2012). This makes its recovery very difficult, but once extracted, shale is no different from conventional natural gas. It may be transported via existing pipelines and condensed into liquefied natural gas (LNG). Shale gas extraction became viable due to the development of hydraulic fracturing techniques, which were created in 1947 and came into commercial use in 1949 in the United States (Stevens, 2010). But only in the late 1980s and early 1990s has the combination of hydraulic fracturing, or fracking, with horizontal drilling designed by Mitchell Energy made large-scale shale gas extraction economically feasible (Stevens, 2010). This ushered the "shale revolution" in the United States (Brooks, 2011).

The "shale revolution" (Brooks, 2011), however, has experienced some obstacles. The excessive use of water, rapidity of well depletion, and the need to drill over very wide areas are issues of concern in shale extraction (Stevens, 2010). Shale wells may have a lifetime of eight to twelve years, compared with thirty to forty years for conventional natural gas wells (Stevens, 2010). These issues, however, are being addressed by continuous advancements in technology, making extraction more productive.

Shale gas extraction via hydraulic fracturing with horizontal drilling is a contentious technique, criticized around the globe due for the possible environmental impacts, lack of adequate regulation, policy and control. This technique uses millions of liters of fracturing fluid, which is typically consistent of 99 percent water with a variety of chemical additives and propping agents like sand. The fracturing fluid is typically pumped into either an oil or gas well "at high pressure in order to create fractures in the rock formation that allow oil or gas to flow from the fractures to the wellbore" (Jackson, Pearson, Osborn, Warner, & Vengosh, 2011). The propping agents allow for the fractures to stay open once they are created under pressure. Depending on the site, 15 to 80 percent of the injected "fracturing fluid" is recovered at the wellhead (Jackson, Pearson, Osborn, Warner, & Vengosh, 2011) as "flowback" – waste that is "typically stored in open pits at the well site prior to disposal" (Earthworks, 2011). The remaining waste remains underground. Some chemicals that may be in fracturing fluid and flowback are known to be toxic to humans and the environment in minimal quantities, while others are well-known carcinogens (Earthworks, 2011). Chemical additives used in fracking may contaminate soil, surface and groundwater, and cause the deterioration of air quality due to evaporation of flowback and methane gas at extraction. Flowback vapour exposure may also harm human brain, nervous, cardiovascular, and respiratory systems (Earthworks, 2011). It has been widely argued to what extent such effects are probable if fracking is properly carried out.

Proponents of shale gas extraction believe that this fuel will revolutionize the energy industry, by decreasing carbon dioxide emissions (via the reduction of the use of oil and coal: natural gas is 30 percent less carbon intensive than oil, and 50 percent less intensive than coal) and by enhancing energy security (Kefferputz, 2010). The expansion of the natural gas industry would also decrease greenhouse gas emissions. Natural gas also has potential to become a transport fuel in the future. Domestic development of shale gas will reduce the dependence on foreign oil and gas imports, making states more self-sufficient. Some experts believe that shale gas has the potential of becoming an ideal bridge fuel for the next half a century, while the industry of renewable energy matures. Notwithstanding, shale gas has the capability of providing energy security to all states, reducing countries' dependence on foreign resources and allowing for diversification. This is especially important for China – a country heavily depended on foreign oil and gas imports. More energy supply from onshore resources in China may help relieve regional tensions in the South China Sea and allow for China to become less dependent on the Middle East for gas, thus reducing tensions with the United States (The Economist, 2012a).

Shale Gas Development in China

Natural gas imports in China have increased by 58 percent in June 2012 from a year earlier to 7.27 million metric tons (Hall, 2012), and natural gas consumption increased by about 15 percent a year since 2000 (The Economist, 2012b). Currently, natural gas comprises about 4 percent of China's gross domestic consumption, but the 12th five-year plan placed a target of 8 percent share of natural gas in the overall energy mix by 2016 (The Economist, 2012b). Although growth of 4 percentage points by 2016 seems small, an increase in one percentage point in China's consumption equates to about 25 billion cubic meters a year (The Economist, 2012b).

Shale gas provides a potential solution to the Chinese energy surge in the eyes of the Chinese officials (Hall, 2012). The government had set a target of 6.5 billion cubic meters a year of shale gas production by 2015 from nearly zero this year (Hall, 2012; The Economist, 2012b; Shaofeng & Qiang, 2012). The Chinese National Energy Administration (CNEA) further hopes to produce between 60 to 100 billion cubic meters a year by 2020 (Hall, 2012; The Economist, 2012b). Beijing is looking to imitate a decade long growth of the commercial shale industry in the United States, which grew from 2 to 23 percent from 2001 to 2010, in five years between 2015 and 2020 (Lu, 2012). The field is being pioneered by Chinese national oil companies – PetroChina, a subsidiary of CNPC, and Sinopec had set production targets of 1 and 1 to 2 billion cubic meters per year of shale gas by 2015 respectively (Lu, 2012). CNPC was the first to start gas shale exploration in China (Jian-chun & Zhi-hong, 2012). The International Energy Agency predicts that total gas production in China may increase fivefold to 475 billion cubic meters by 2035, with almost 200 billion cubic meters coming from shale gas (The Economist, 2012b).

In order to meet the targets for shale gas production, Beijing announced financial incentives for the developing industry as well as measures to encourage competition and liberalize the natural gas market (The Economist, 2012b). But production agreements that would satisfy all the parties involved – owners, operators, and provincial and central governments – will be difficult to create, as Jingzhou Tao of Dechert law firm stated (The Economist, 2012b). Liberalization of the market will also be challenging. Currently, China’s shale gas and coal-bed methane industries are subsidized approximately to 3 cents USD per cubic meter (The Economist, 2012d). Shale gas prices are to be market-based, however, and producers shall be allowed to charge higher prices than allowed by the state controlled system. The Chinese National Energy Administration will endorse the creation of special shale gas funds and create a shale gas laboratory in Langfang, near Beijing, sponsored by PetroChina (Jian-chun & Zhi-hong, 2012).

China had carried its first auction for shale projects in June-July of 2011, with Sinopec and Henan winning a block each for lease (Lu, 2012). Shale gas reserves are mainly distributed in the south, northwest, north, northeast, and Qinghai-Tibet, with the south and northeast having the most favorable conditions for extraction (Jian-chun & Zhi-hong, 2012). Junggar, Tuha, Bohai Bay, Ordos, and Qaidam basins consist of 20 to 25 thousand square kilometers of terrestrial shales that are located in areas less favorable for extraction (Jian-chun & Zhi-hong, 2012). China has tested 22 shale oil and gas wells by October 2011, of which Sinopec drilled 10 wells, CNPC drilled 8 and Yanchang Petroleum drilled 4 (Jian-chun & Zhi-hong, 2012). 17 out of 22 wells were shale gas wells with the maximum well test production rate of 60,000 cubic meters a day (Jian-chun & Zhi-hong, 2012).

China’s central government categorized shale gas as an “independent” resource and announced a new national resource tax in November 2011 (Lu, 2012). This allows private companies to participate in the second leasing bid scheduled for August 2012 for 20 blocks in 10 provinces (Lu, 2012). Between 30 and 200 small to medium sized companies have already registered for the bid by the Ministry of Land and Resources (Lu, 2012). CNPC, Sinopec and CNOOC, however, have not registered for the bid, possibly due to an agreement with the central government that will allow them keep access of 75 percent of all shale reserves in China (Lu, 2012).

Sophie Lu, a consultant with Regester Larkin Energy, (Lu, 2012) outlines the current power tensions among four different types of actors involved in politics behind shale gas development – national oil companies; provincial level government; coal companies, utilities, and regional oil and gas producers; as well as central government factions. CNPC, CNOOC and Sinopec – the three national oil companies – not only have the control over 75 percent of land containing shale gas reserves but also have control over national pipeline networks. The NOCs decide who can ship oil and gas across the country. They also have considerable political power. Su Shulin, Sinopec’s general manager is both a Chinese Communist Party secretary and governor of Fujan province (Lam, 2011). Jiang Jiemin, CNPC’s general manager and party boss served as Qinghai vice-governor (Lam, 2011). The former CEO of CNOOC, Wei Liucheng, is a full member of the Chinese Communist Party Central Committee and is a former governor of Hainan (Lam, 2011). This is and will continue to play a role in the NOCs’ control of shale reserves and the future development of the industry.

Additionally, the majority of shale gas fields are located in “traditionally powerful provinces,” such as Hebei, Shaanxi, Shandong, and Shanxi, where local governments have a much greater influence in infrastructure development and have “significant leverage and interest in gaining stakes in shale gas development” (Lu, 2012). Coal companies and second-tier regional companies are also among the competitors in shale development – large portions of shale gas reserves overlap with coal beds owned by mining companies such as Datang, Fushun Mining, and others. All of the above would play significant roles in the future development of the shale gas industry.

Collaboration with Western Companies at Home and Abroad

Chinese officials encourage partnerships between domestic producers and foreign oil and gas companies (The Economist, 2012b). In November 2009, the United States and China introduced the*U.S.-China Shale Gas Resource Initiative* to give momentum to the development of shale gas in China and encourage American oil companies help Beijing tap into its shale reserves (The White House, Office of the Press Secretary, 2009; Newman Hood, 2012). Giants like BP, Chevron and Royal Dutch Shell have joint ventures with Chinese companies. Chinese national oil companies have invested into American natural gas producers. Sinopec agreed to buy a third of Devon Energy Corporation for $2.5 billion in January 2012 (Polson & Haas, 2012; Hook, 2012b), and CNOOC had invested $2.2 billion into a shale project by Cheasapeake Energy in 2010 in order to acquire the necessary knowledge and expertise from experienced American producers (Mufson, 2010). In March 2012, Royal Dutch Shell signed China's first shale gas production sharing agreement with PetroChina, CNPC's subsidiary, to help China extract into its shale resources (Swint, 2012). Schlumberger, an oil-services company with extensive experience in shale gas extraction and hydraulic fracturing, took a 20.1 percent stake in China's Anton Oilfield Services Group in early July 2012 (Denning, 2012). Joint ventures like this have recently arisen in China, with foreign companies trying to gain entry to the vast Chinese shale potential by partnering with domestic counterparts.

China's Obstacles in Attaining Shale

Although the outlook for the development and extraction of shale gas in China seems favorable, several issues will have to be addressed to make shale extraction in China successful. Chinese deposits may be a lot less accessible than the ones in North America, possibly making their extraction less profitable and more difficult (The Economist, 2012b). It is twice more expensive to set shale gas wells in China than in the United States (Gao, 2012). For instance, the cost of a shale gas well drilled by CNPC in Sichuan is $11 million in comparison to $4-6 million spent in the United States. It may also be more difficult to locate potential and best plays, due to the shortage of past exploratory activity. Technologies that have been successful in North America may not be as successful in Asia due to the differences in geology.

There is lack of a service infrastructure and a supply chain (to transport and manage equipment and large quantities of water) necessary to set up drilling operations in China. Since shale gas extraction requires immense amounts of water, an infrastructure has to be created to make such quantities available. The issue of gathering produced gas from wells also has to be addressed, and the Chinese pipeline network has to be expanded. Gas is mainly delivered using pipelines, which cost millions in capital investment per kilometer built. For the Chinese shale gas industry to develop, the government would not only need to invest into development and exploration but also in the pipeline infrastructure. The existing pipelines only serve conventional gas fields and new infrastructure is necessary to connect shale fields to markets (The Economist, 2012b). China is, however, well capable of building pipelines in record time, as evident with the most recent gas pipeline project in Turkmenistan (The Economist, 2012b).

Water supply may also slow down the development of shale. Some of China's big shale fields are in the far northwest of the country away from the water necessary for hydraulic fracturing (The Economist, 2012b). Most shale gas reserves are located in water scarce regions of China – the Tarim, Tuha, and Junggar basins are in the dessert in the northwest; Ordos, Bohaiwan, North China, and Songliao basins are in north and northeast with slightly better conditions (Gao, 2012). Only Sichuan and South China basins are in relatively water rich regions (Gao, 2012). Each shale drilling well in China would require at least 4 million gallons of water per well for fracturing, based on the average use of 2 to 4 million gallons per well in the United States, where lower depth of resource (than in China) allows for less water used (Gao, 2012). This will thus require about 40.8 billion gallons of water to achieve the production rate of 50 billion cubic meters a year over 10 years – a number equivalent to residential water use of a Chinese city of 2.6 million people annually (Gao, 2012). China's severe water shortages had already constrained economic growth during the last decade (Gao, 2012). Therefore, the development of shale in China may be hampered by lack of water resources.

Environmental concerns associated with shale gas development, such as deep water and air pollution, as well as the correlation between increased hydraulic fracturing activities and an increase in number of earthquakes around the shale plays may impede the development of shale in China. Although the expansion of the energy industry is of central importance for the Chinese leadership, there has been an increase in environmental and health consciousness among Chinese in past several years (Inch, 2012). Shale exploration and extraction may cause significant environmental disasters and increase water pollution dramatically if it is not carried out properly. China's sizable targets for development will require at least 1,000 wells to be commercially viable by 2015 (Addison, 2012) – this will rush developers who may run the risks of not following the industry's best practices.

Shale Benefits

Natural gas is the cleanest of hydrocarbons and its use and relatively low gas prices (provided by abundance of shale resources) will allow it to displace some of the coal and oil used in China. The largest shift may occur due to the displacement of coal by gas in power generation – the use of combined-cycle gas turbines makes it both cheaper to generate electricity and releases up to 50 percent less carbon dioxide emissions (The Economist, 2012a; The Economist, 2012c). Analysts, such as Michael Stoppard (HIS CERA), believe that gas power stations are a "low-regret" option, being less expensive than renewables such as nuclear (The Economist, 2012c). Gas is also flexible – it may be used in both residential and industrial sectors, may provide feedstock to the petrochemical industry and is the transportation fuel of the future (The Economist, 2012c). In the long run, natural gas, and shale specifically, would allow for greater energy security in China, reduce its reliance on foreign imports of gas and domestic coal, and curb greenhouse gas and carbon dioxide emissions.

The Future of Yeyanqi

China's rush to usher the *yeyanqi* revolution is understandable given the growing energy needs of the world's second largest economy. The targets set by the 12th five year plan for shale seem very optimistic and borderline unrealistic. The past decade and a half, however, had made China an example of unprecedented growth in all respects with unimaginable speeds. Thus, although China may come short of the shale development goals in 2015 (Gao, 2012), it is very likely that the goals of 60 to 100 billion cubic meters of shale gas production a year will be met by 2020. It is likely that the Middle Kingdom will become the largest producer of shale in the world by 2035 as the International Energy Agency (IEA) predicts. The only hope is that China meets these expectations, while assuring for quality and best practices in the industry and following IEA's "Golden Rules" for the development of unconventional shale resources that underline the need in full transparency, monitoring and control of the environmental impacts, improved regulations, and careful choice of drilling sites, among others (International Energy Agency, 2012). If this will not be done, the rapidity of development of shale in China may have dreadful consequences for the Chinese environment and population, already strained by terrible environmental conditions.

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