U.S.-China Cooperation in Natural Gas and Nuclear Energy: Diverging Energy Profiles and Emerging Opportunities

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Abstract

Some notable divergence is emerging in recent years between the energy profile of the United States and that of China. The robust production of unconventional oil and gas is increasing the level of energy self-sufficiency for the United States while China's continued economic growth is increasing its import dependence. Political drive for bilateral cooperation in the area of clean energy, combined with comparative advantages arising from the diverging energy profiles, is bringing the two countries closer to cooperate on nuclear energy and shale gas.

Keywords: *United States, China, natural gas, nuclear energy, clean energy cooperation*

1. Introduction

As President Barak Obama gained a mandate to lead the United States for the second term and President Xi Jinping ascended to the helm of government in China, the two countries have a renewed political commitment to cooperation on clean energy and climate. In spite of the high level support for bilateral cooperation, the story of bilateral clean energy relations is complex and often embedded with tensions. Both countries see clean energy sources like renewable energy as a focus area for technology development and manufacturing, and similarly strive to expand global market share for their renewable energy technologies and equipment. For example, today the two economies are competitors in both solar panel and wind turbine industries.

Meanwhile, there are also some important differences between the US and Chinese energy economies. The development of unconventional energy is increasing the level of energy self-sufficiency for the United States as well as the US potential as an energy supplier in the global market. The *shale gas* revolution has also helped reduced the level of U.S. greenhouse gas emissions from its electricity sector. Meanwhile, China's energy consumption and import dependency continue to rise, fueled by economic and population growth and modernization trends. In an effort to address its energy import dependence and to achieve a more sustainable path of economic development, the Chinese energy policy places particular focus on the development of natural gas and nuclear energy, in addition to renewable energy. This focus was renewed, for example, in the country's White Paper on Energy Policy, released in October 2012. These areas are important to the United States, too. In fact, there is an emerging complementary nature in the two countries' energy profiles. Nuclear energy and natural gas have thus risen up as important dimensions in U.S.-China energy relations today. In fact, bilateral cooperation in nuclear energy and natural gas is born out of increasing divergence in the energy profiles of the United States and of China.

2. Nuclear Energy

Nuclear energy is a low-carbon emitting source of electricity that is commercially and technologically proven. Increasing focus on global climate change and clean energy technologies has kept nuclear energy among the mix of viable electricity sources.

2.1. US Scene

With 100 reactors online, the United States is home to the largest commercial nuclear fleet in the world. Nuclear energy provides about 20% of total national power generation capacity today. Since 2000, 73 reactors have received a 20-year license extension, including 11 units since the Fukushima accident in March 2011 (Nuclear Energy Institute 2013). Fourteen license renewal applications are currently under review. More significantly, the US Nuclear Regulatory Commission (NRC) issued in February 2012 the first construction and operation permit since the Three Mile Island accident in 1979. The Vogtle Project in Georgia will have two advanced nuclear reactors—Westinghouse AP-1000—in commercial operation by 2017/2018. Later in the same spring, another project received the NRC permit to build two AP-1000 reactors, in South Carolina. These four units brought the total number of reactors under-construction to five in the United States.

Nuclear energy is among the mix of clean energy sources promoted by the Obama Administration. In the immediate aftermath of the Fukushima nuclear accident, President Obama expressed support for nuclear energy. The US nuclear industry, however, faces a significant headwind today due primarily to large construction costs and the unresolved public policy question over spent fuel management. Also, the availability of economically competitive fossil fuel alternatives is compounding the challenge. Low price natural gas is putting pressure on the economic viability of nuclear reactors—as well as aging coal-fired power plants—across the country. In recent years, several US utilities have announced decision to decommission commercial nuclear reactors well short of when their operational licenses expire. The Oyster Creek plant in New Jersey, the Kewaunee plant in Wisconsin, the Crystal River plant in Florida, and the Vermont Yankee plant in Vermont all had valid operational licenses and their owners have cited the fierce competition from other energy sources among key reasons for their early decommissioning.

The US nuclear industry is now focused on Small Modular Reactors (SMRs) as a pathway to reverse its declining fortune and to maintain its global competitiveness. SMRs offer a range of benefits, including the ability to match smaller grid capacity in remote locations or developing countries, and smaller upfront investment requirements for construction. In particular, the size of the upfront investment appeals to US utilities. Unlike cohorts in many other countries, the US power sector is comprised of over 3,000 electric utilities and their average financial capacity is quite small—certainly not large enough to comfortably undertake nearly a 10 billion dollar commitment commanded by construction of an average 1,000+ megawatt nuclear reactor.

A number of US reactor builders are designing SMRs and the industry efforts are matched by US government support. The US Department of Energy announced in March 2012 a cost-sharing grant to companies that would facilitate design certification and licensing for up to two SMR designs over five years in efforts for SMR commercialization by 2022. Last fall, Babcock and Wilcox won the first round of selection. The second winner will be determined by January 2014. Meanwhile, US stakeholders—including energy policymakers, nonproliferation experts and industry executives—continue to mull the implications of shrinking nuclear power generation on US national security and energy security without an obvious solution.

2.2. Chinese Scene

The picture could not be more different for China's nuclear industry. With 30 reactors under construction—roughly equivalent to 40% of the global nuclear construction, China has the fastest growing nuclear energy program in the world. For a country whose commercial nuclear power generation program took off only under the Tenth Five-Year Plan (2001-2005), the Chinese nuclear sector has a remarkably ambitious expansion plan (World Nuclear Association 2013). China has brought 17 reactors online that represent about 1 to 2% of total national electric capacity today.

Nuclear power production is a key focus for China, whose energy mix is dominated by coal, and reducing coal's share is a priority in China's broad energy strategy. For example, the mandatory 20 percent energy intensity reduction target in the 11th FYP (2006-2010) and the calls under the 12th FYP (2011-2015) for a 16% reduction in energy intensity as well as a 17% reduction in carbon intensity strongly supported the expansion of nuclear power generation.

Following the Fukushima nuclear accident, China suspended government approvals for new nuclear plants while undertaking safety reviews. Due to the resulting construction delay, China's current installed capacity target for 2020 is 58 GW—far short of their pre-Fukushima aspiration to 86 GW (World Nuclear Association 2013). Nonetheless, China remains committed to nuclear energy and the country's White Paper on Energy Policy stipulates plans to "invest more in nuclear power technological innovations, promote application of advanced technology, improve the equipment level, and attach great importance to personnel training" (Information Office of the State Council 2012). The country's targets for installed capacity may rise to as much as 200 GWe by 2030, and 400 GWe by 2050 (World Nuclear Association 2013).

Chinese aspirations, however, face challenges in terms of technology development, institutional capacity, and human capital development. On the technology front, China has ambition to become a global reactor supplier and has been striving to indigenously develop advanced reactor designs that are in line with what is produced and sold by globally established suppliers. However, roughly half of the units under construction prior to the Fukushima nuclear accident were based on designs originally developed in the 1960s and they do not capture many advances that have been made available in the newer reactors. Because nuclear reactors generally operate for roughly half a century, building today the reactors developed several decades ago would mean that such a fleet of reactors would be about a century behind. If there were such a thing as a positive consequence of the Fukushima accident, however, China introduced a new nuclear safety plan after the accident and the stricter standards called for under the plan will likely facilitate phasing out older designs (Zhou 2012).

Also, institutional capacity has been another area for improvement. Concern is growing over a gap between the pace of nuclear power expansion in China and infrastructural capacity and human capital requirements. For example, China is yet to finalize and unveil an atomic energy law which has reportedly been under consideration since the 1980s. Additionally, the effectiveness of its nuclear regulators and the lack of human resources have been cited as key concerns (World Nuclear Association 2011). For example, China is said to need 25,000 additional nuclear experts by 2020 (Kong 2010).

2.3. Civilian Nuclear Energy Cooperation

The US and Chinese governments have enjoyed a wide scope of cooperation in the nuclear energy field, covering nuclear energy technology, safeguards and security, spent fuel management, emergency management, radiological security as well regulatory affairs. For example, under the auspices of the *U.S.-China Peaceful Uses of Nuclear Technology (PUNT) Agreement,* signed in 1998, the two countries cooperate on technology matters for the current fleet of operational reactors and the research and development of advanced civilian nuclear technologies, such as fast reactor technologies. Also, since 1981, U.S. and Chinese nuclear regulators have been engaged in the exchange of information and specialists, as well as collaborative research and joint seminars on matters including assessment and inspection of construction, operation and decommissioning, emergency preparedness and radiation protection (U.S. Nuclear Regulatory Commission 2008).

Bilateral cooperation is deepening and expanding especially since the Chinese purchase of Westinghouse designed AP-1000 reactors in 2007. For example, personnel training have always been a key part of the bilateral cooperation and the NRC has been hosting Chinese regulators, but following the AP-1000 sale, the NRC has also sent several resident inspectors to China to gain lessons learned from ongoing AP-1000 construction projects in China (Nuclear Energy Agency 2012).

The purchase in 2007 of Westinghouse developed AP-1000 reactors was a significant development for China. The decision to deploy reactors that had not yet been certified by the US regulators presented both a risk and opportunity to the Chinese. Yet, in the end, the Chinese determined that the value of the AP-1000 reactors to its ongoing efforts to develop advanced reactors outweighed the risks associated with serving as a test bed for this new reactor design. Construction of the advanced pressurized water reactor (PWR) thus started in 2009, and the Sanmen Unit 1 in China’s Zhejiang Province is slated to be the world’s first AP1000 reactor to commence operation in 2014.

This development brought the nuclear industry of the two countries closer than ever before. For example, Westinghouse has been partnering with State Nuclear Power Technology Corporation (SNPTC) and Shanghai Nuclear Engineering Research & Design Institute to jointly develop a AP-1000-based reactor, which China hopes to begin exporting later in this decade (World Nuclear News 2012). Moreover, Westinghouse and SNPTC now have plans to develop SMRs that are based on Westinghouse’s SMR technology with the aspiration to market them globally.

The United States has the wealth of regulatory and operational expertise as well as the design capability, yet the US nuclear industry has lost the robustness it once had in manufacturing and deploying nuclear reactors. In contrast, China has a growing nuclear energy sector with a strong potential for exporting its domestically developed reactors yet is short of regulatory and operational expertise. Notwithstanding the competition that will likely arise as China’s nuclear industry matures, the nuclear industries of the two countries are currently in a highly complementary situation, yielding cooperation in both public and private sectors. This cooperation will likely continue for some decades.

3. Natural Gas

Natural gas markets around the world have experienced dynamic growth and transformational change over the last several decades, driven by the advent of U.S. shale revolution. With its lower carbon emitting profile than coal, natural gas is an increasingly attractive energy source for economies around the world, including the United States and China.

3.1. US Scene

Only a decade ago, the United States was expected to become increasingly reliant on natural gas imports. The Energy Information Administration's (EIA) 2003 forecast suggested nearly a 50% rise in domestic natural gas demand to 34.9 trillion cubic feet (tcf) in 2025, and a production decline to 22.5 tcf in the same year (EIA 2003). The domestic natural gas outlook could not be more different today. The success and scale of this development has fundamentally reshaped the US gas market. Shale gas, which accounted for a negligible share of total US gas production a decade ago, now makes up roughly a third of domestic gas output. By 2035, this share is expected to grow to about half of domestic production.

The successful development of shale gas has had several key implications for the US economy. In the power sector, natural gas has become a viable fuel choice, facilitating the retirement of aging coal-fired power plants and nuclear power plants. The fuel-switch in the power sector, combined with the economic downturn of recent years, has lowered the level of greenhouse gas emissions in the United States. Shale gas development has also spurred investment interest in manufacturing sectors that rely on natural gas feedstock, as well as investment interest in transportation related natural gas fueled technologies and infrastructure. Additionally, the United States is now expected to become a net natural gas exporter by 2020. Natural gas producers and liquefied natural gas (LNG) terminal project stakeholders are eying natural gas markets abroad as important outlets for the commodity they believe to be undervalued.

3.2. Chinese Scene

Natural gas has emerged since the early 2000s as a fuel option that may help the Chinese leadership address the country's growing energy import dependence and environmental concerns. China's domestic natural gas production has been on the rise—27.2 billion cubic meters (bcm) in 2001 to 94.5 bcm in 2010 (BP 2010)—although the demand continues to outstrip supply. China plans for the share of natural gas in total energy requirements to reach 8% by 2015 and 10% by 2020. Shale gas can play an important role in the government efforts to foster natural gas use in the country. A 2013 assessment of international shale oil and gas resources by the EIA cited technically recoverable shale gas resources in China at 31.58 tcm (1,115 tcf), making China the top resource holder in the world. The Chinese government appears eager to capitalize on this development. China aims for an annual production level of 60–100 bcm (NDRC 2012), which would be equivalent to the entire volume of natural gas the country produces today.

China's shale gas industry, however, is still in a nascent stage and the road to successful commercialization may be long and winding. First, Chinese geology is believed to be more difficult for shale gas extraction. For example, Chinese shale formations lie much deeper than their American counterparts, thus raising the cost of extraction. Also, their high clay content renders it difficult for Chinese shale formations to shatter during the injection process and, thus, lowers their productivity. The lack of technology and domestic expertise add to the challenge China faces in exploiting its shale gas resources. The US shale gas revolution has resulted from a confluence of technological, economic and regulatory factors, but the advancement in technologies and accumulation of expertise were two of the most crucial factors. Technological advancements in hydraulic fracturing and horizontal drilling, as well as the use of real time integration of down-hole data have immeasurably expanded the productivity of shale gas plays in the United States. Moreover, the ability to manage and apply reservoir-specific technologies—which the US experts gained through the first-hand experiences over several decades—was essential to unlocking the shale gas potential in the United States.

Additional hurdles for China may include price controls on natural gas, which slows the deployment of natural gas—conventional or unconventional—by forcing companies to import gas at a loss, as well as the country's natural gas pipeline system, which is already committed to carrying conventional gas supplies. China is showing some progress in shale gas infrastructure development in that China National Petroleum Corporation announced in June 2013 its decision to build the country's first ever pipeline dedicated to shale gas transportation. But, the pipeline network needs to expand further if the country wishes to transport newly found shale gas to capitalize on its resources.

3.3. Natural Gas Cooperation

The launch of the United States-China Shale Gas Resource Initiative in November 2009 was a dawn of high-level bilateral engagement on shale gas. Announced by President Obama and then Chinese President Hu Jintao, the initiative covers resource assessment, technical cooperation, investment promotion, study tours, and workshops. The two countries have also come to exchange insights into matters associated with regulatory and environmental framework that are considered essential for the sustainable development of shale gas.

The private sector is an integral part of bilateral engagement over shale gas, just as it is over nuclear energy. US industry experiences with shale gas and the shale gas resource wealth in China present a multitude of opportunities for the two economies to engage. This engagement encompasses investments as well as trade between the two countries.

First, political stability and a transparent legal system have illuminated the attractiveness of US shale gas for investors around the world, including Chinese. Since 2008, U.S. shale plays have attracted over $133.7 billion, including $26 billion from 21 joint ventures between U.S. and non-US companies (EIA 2013). Also, countries like China that are considering unlocking the economic potential of domestic shale gas resources see involvement in US shale projects as an opportunity to shorten their technological learning curve.

In November 2010, CNOOC Ltd., purchased assets in the Eagle Ford Shale Basin in South Texas for $1.08 billion from the US company Chesapeake Energy Corporation. This development was followed by the CNOOC acquisition of one-third of Chesapeake Energy's Niobrara shale project in Colorado and Wyoming for $570 million two months later (Polson and Duce 2011). Momentum appears to be picking up since the beginning of this year. In May 2013, Sinochem of China entered into a joint venture with Pioneer Natural Resources—a US energy company based in Texas—for $1.7 billion and acquired a 40% stake in the Wolfcamp shale play in West Texas (BusinessWeek 2013). In July 2013, Sinopec closed a $1.02 deal with Chesapeake Energy Corp. to purchase a 50% stake in an Oklahoma field (Chesapeake 2013).

Second, the Chinese shale sector presents opportunities to US and western oil and gas companies and oilfield service companies that wish to capitalize on their shale gas expertise in China today. China's shale industry is at a nascent stage where a significantly limited number of wells have been drilled thus far.

Since early 2012, US-based Chevron has been exploring for shale gas in Guizhou Province (Guo 2012). Also, ConocoPhillips—another US-based multinational energy company—is undertaking with Sinopec a joint study on unconventional oil and gas development, including resource surveys and test well drilling in Sichuan Province (Zacks Equity Research 2012). Other international oil and gas companies are carefully assessing their business prospects in China. BP—a multinational energy company based in the United Kingdom—is working with Sinopec to conduct risk assessments in Kaili deposits in Guizhou Province (Bai and Chen 2010), while Anglo-Dutch energy company Royal Dutch Shell and PetroChina, a subsidiary of China National Petroleum Corporation, have signed a 30-year agreement to appraise and possibly develop shale gas reservoirs in Sichuan Province (Oster 2010). As for service companies, US-based Baker Hughes joined forces with Honghua Group, China's largest oil-drilling equipment exporter, to assess shale gas prospects in China in December 2013 (Guo 2013). Also, Anton Oilfield Services Group of China sold a 20% stake to Schlumberger—a French company with a significant presence in the United States—as part of the two companies' ongoing efforts to develop drilling fluids and well-cementing services (Hart 2012).

Lastly, the US shale revolution presents natural gas trade opportunities between the two economies. In terms of LNG export approval, the current US law differentiates the export projects only by whether or not the project destination economy has a Free Trade Agreement (FTA) with the United States. Of the 18 economies that have a FTA with the United States requiring national treatment in natural gas trade, only South Korea and Chile are in the top 15 consumers of global LNG supplies.

Potential importers, including the Chinese, are attracted to the prospect of a gas trade that is based on a more flexible pricing term linked to the Henry Hub pricing point, as opposed to the traditional one linked to the global oil price level. There are some significant price differentials between the North American and Asia-Pacific gas markets today: gas prices are about $4 per million British thermal unit (mmBtu) in North America, and $13–$16/mmBtu in the Asia Pacific. This price differential—even after costs incurred for liquefaction and shipping raised the price of North American natural gas delivered to Asian markets—make the prospect for exports to Asia particularly attractive to many producers in the United States as it would arguably drive up the currently low price of natural gas in the United States and create jobs in their industry.

Moreover, LNG import from the United States can bring about supply diversification benefits. Asia, including China, is forecast to account for nearly two-thirds of global LNG demand growth through 2030. China's natural gas imports are sourced half from pipeline gas and the rest in the form of LNG, where traditional LNG suppliers like Australia, Qatar and Indonesia lead the pack (EIA). The addition of US natural gas supplies can further the Chinese sense of energy security through supplier diversification.

4. Conclusion

Nuclear energy and natural gas are important parts of the US and Chinese energy economies today. These energy sources are seen to advance energy security and clean energy objectives of policymakers in the two capitals today. However, the industry landscape presents different strengths/advantages to the United States and China, respectively. The US nuclear industry has a wealth of expertise that is left underutilized today while the Chinese nuclear industry faces its expansion vision that surpasses its institutional and technological capacities. The contrasting situations are bringing together scientists, and regulators as well as business executives from the two countries. As for natural gas, the successful commercialization of shale gas resources in the United States and China's urgent tasks to address severe air pollutions and rising energy import dependence are starting to generate investment and trade opportunities between the two. The United States and China may find each other competitors in the future, but there is much to be gained by both economies through cooperation in nuclear energy and natural gas fields today.

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