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Expanding Natural Gas Use in China

A Joint Sino-U.S. Research Report

Executive Summary

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FOREWORD
(U.S. Sponsor)

I am pleased to introduce this study, which addresses an important opportunity for environmental protection in China and for U.S.-China environmental cooperation. Natural gas burns cleaner than coal and oil and thus helps to minimize harmful emissions of sulfur dioxide, particulates, nitrogen oxides and other air pollutants. It also produces lower levels of carbon dioxide—the most important anthropogenic greenhouse gas (GHG) —relative to other fossil fuels. In China's case, replacing highly polluting coal use with more extensive use of domestically produced and imported natural gas could have enormous benefits in cleaner air, reduced public health damage and reduced GHG emissions. The United States and China have strong common interests in working together to achieve these goals. This was recognized in one of ten Statements of Intent (SOI) on environmental cooperation signed by the Administrator of the U.S. Environmental Protection Agency with the Chairman of China's State Development Planning Commission in April 1999. This SOI initiated a cooperative expert study on opportunities to expand use of natural gas in China and the environmental benefits this could produce.

The State Development Planning Commission designated the University of Petroleum-Beijing to coordinate China's research contribution, working with the Pacific Northwest National Laboratory in the the United States. After two years of intense effort, the authors have succeeded in producing a high quality summary report which documents the potential for and environmental benefits of expanded natural gas use in China, identifies key barriers restraining rapid development of China's gas sector, and identifies opportunities for further U.S.-China collaboration toward that goal.

Market reforms and technology development have helped expand the use of natural gas in many regions of the world over the past decade. Several countries have developed competitive wholesale and retail natural gas markets that result in lower costs and greater convenience for consumers. They have also learned a great deal about the careful crafting of policies governing these reforms. Technological advances in areas such as seismic imaging, drilling, and high-temperature gas turbines have helped to increase the availability and affordability of natural gas. Other technologies, such as fuel cells and gas-to-liquids conversion, are under development and promise to further expand the potential uses of natural gas.

Because natural gas until recently played a minor role in national energy policy, many of these international developments have not yet been replicated in China. As late as 1997, natural gas accounted for only two percent of the country's energy demand mix, far below the world average of 25 percent. China's interest in expanding natural gas usage has grown over the past few years as air quality continued to deteriorate, especially in urban areas. More ambitious plans are now on the drawing board to make natural gas a significant source of new energy in China over the next 20 years. To make this vision a reality, however, new measures will be needed to encourage exploration and development, transportation, distribution, and, perhaps most importantly, market demand

for natural gas. There are significant opportunities for drawing on the advanced technologies and policy experience available from the U.S. and other countries to support these developments in China. This document aims to inform policymakers of the important issues related to expanding natural gas use in China and to outline collaborative opportunities that could help overcome some of the obstacles. I believe that the report makes a significant contribution in this regard, and represents a major constructive step in the ongoing cooperation between China and the U.S. to promote cleaner energy and a cleaner environment.

Paul Stolpman
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FOREWORD
(Chinese Sponsor)

The State Development Planning Commission was pleased to cooperate with the U.S. Environmental Protection Agency on ways to boost natural gas use in China. This study outlines key measures to accelerate development of China's natural gas industry and suggests future steps the U.S. and China can take together to help improve development of the sector.

China's natural gas sector is now receiving great attention. The Chinese government is stimulating the industry by developing new policies to push forward natural gas use. This study adds to the measures to develop clean energy sources such as natural gas, and clarifies future opportunities for cooperation between China and the U.S.

Experts from the University of Petroleum-Beijing and Pacific Northwest National Laboratory worked hard to produce study results that are helpful to governmental decision-makers in the natural gas industry. Also, this project has helped build confidence in cooperating with the U.S. on energy and environmental issues. China will continue conducting market reforms and developing technology to drive the use of natural gas in China. We will make greater use of international human resources to train Chinese personnel in the natural gas sector. China will also need to attract more foreign investment to transfer advanced technologies to drive the development of the gas industry.

China plans to make natural gas a significant source of new energy over the next 20 years. To make this vision a reality, however, new measures will be needed to encourage exploration and development, transportation, distribution, and market demand for natural gas. This document helps to inform policymakers of the important issues related to expanding natural gas use in China and to outline collaborative opportunities that could help to overcome some of the obstacles.

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Trends and Overview

China's long dormant natural gas sector looks set to begin a period of rapid growth. Expanded use of natural gas as a substitute for dirtier fuels could help address many of the country's severe air pollution problems, including greenhouse gas emissions. While important policy changes have occurred over the past few years, a number of obstacles could constrain development of the natural gas market. This study identifies these obstacles and describes ideas for U.S.-China collaboration to overcome them.

China has demonstrated its intention to boost natural gas as a substitute for coal and oil. The misconception that natural gas exists in insignificant quantities in China is diminishing. Within the last year, China has announced large gas discoveries in Xinjiang and Inner Mongolia, adding to other relatively abundant reserves identified during the 1990s. Infrastructure for natural gas—including the West to East natural gas pipeline—is being developed to transport gas from remote locations to population centers. Plans for China's first liquefied natural gas terminal in Guangdong are progressing and the terminal could be operating by 2005. And China's major oil and gas companies are being commercialized and encouraged to cut staff, focus on profits, and improve management. These changes could transform the natural gas industry into a dynamic sector capable of fueling cleaner economic growth, but additional measures will be required.

Chinese planners are promoting natural gas mainly for its relative environmental benefits. A heavy reliance on coal over the past five decades has made China one of the most polluted countries in terms of air emissions. Environmental pollution is now widely acknowledged to cost the economy billions of yuan in losses each year due to impacts on human health, agricultural productivity, and human-built infrastructure. The move to natural gas is a step to reverse the environmental damage, and would also have a significant impact on greenhouse gas emissions. Other benefits of expanding the use of gas include:

- Balancing energy supply and demand centers,
- Improving the nation's energy security, particularly with respect to rapidly rising oil imports, and
- Removing bottlenecks in the already strained freight transport sector.

Despite the positive signals in development of a natural gas value chain, stronger government support is needed if China is to maximize the benefit of natural gas. Developing the natural gas system from exploration to end-use requires enormous investment and strong coordination between economic planning agencies, municipalities, environmental protection bureaus, and energy companies. The weakest link in the chain can arrest development of the entire system. As China is transitioning from a planned to market economy, the government needs to establish a more transparent, comprehensive framework in which market-oriented companies can succeed.

Economic reforms in China are beginning to have a noticeable impact on state-owned industrial enterprises, including oil and gas companies. Consolidation and closure of industrial enterprises have improved economies of scale and efficiency. State owned enterprises are facing firmer budget constraints and receiving fewer policy loans from Chinese banks. Many are beginning to focus on profits rather than just output and have begun raising significant sources of finance on domestic and international stock markets. Still, conflicts between central and local authorities often slow efforts to reform as do the rising number of unemployed workers that threaten social stability.

This study outlines important trends in China's natural gas sector and identifies opportunities where China, the United States, and possibly other organizations can collaborate to overcome barriers that prevent rapid development of the industry. It is a relatively modest effort and will require earnest follow-on work to catalyze significant change.

Section 1 provides a brief overview of recent trends in China's energy sector, placing the natural gas sector in proper context. The environmental impacts of expanding natural gas use—including estimated reductions in local and global pollutants— are considered in Section 2. Section 3 describes recent changes in administering and guiding China's gas sector. In Sections 4 and 5, the authors focus on key issues and challenges in the supply, transport and distribution of natural gas. Downstream, or end-use demand, for natural gas is discussed in Section 6. The final section summarizes potential areas of collaboration between China, the U.S., and potentially other international organizations to overcome obstacles to developing the gas sector more rapidly.

Key Issues

Summarized below are the key findings identified in each section of the study.

Environmental: Natural gas has the highest environmental and health value in displacing coal use in the residential sector, but markets are more likely to first develop in the power generation and industrial sectors. For every 20 billion cubic meters of natural gas used in place of coal, sulfur and carbon dioxide emissions would decline by 650 thousand tons (kt-SO_2) and 14 million tons (Mt-C), respectively. Natural gas is already competitive in regions where coal is relatively expensive and a clear winner when environmental costs are included. Greater enforcement of existing environmental regulations would help create market demand for natural gas.

Administration and Policy Development: Important new measures have been enacted to boost gas use including pipeline construction, liquefied natural gas development plans, and generic economic reforms aimed at commercializing state-owned enterprises. Trends are underway to advance market-based pricing of natural gas, and all new gas supply projects are to allocate gas according to market demand. A comprehensive natural gas development framework, however, has yet to emerge. Communicating clear policy priorities, clarifying lines of authority, and enforcing existing laws would promote

development of the gas sector by lowering risk and optimizing resource use. Domestic bond and stockmarket offerings are now playing a larger role in financing natural gas exploration, development, transport, and distribution activities. Foreign investment in onshore activities has been meager, but could grow rapidly if new measures are taken to improve transparency, promote the rule of law, and expand market reforms. Foreign investment can help transfer the technologies needed to make gas use more affordable. Continuing market reforms can help lower the cost of bringing natural gas supplies to end users.

Upstream: China has more domestic gas than once thought, although most resources are located far from centers of demand. Recent discoveries of large fields in Xinjiang and Inner Mongolia have added to the growing resources identified during the 1990s and supported construction of the West-East natural gas pipeline project. Development of China's first liquefied natural gas terminal in Guangdong is proceeding, although China is likely to enter the LNG market cautiously. Progress on importing gas from Russia and other Central Asian countries has been slower. New drilling and imaging technologies can improve the success of finding gas resources economically and Chinese gas companies would benefit from using them on a wider scale.

Midstream: Construction of a cross-country pipeline linking gas supplies in western China with users in the east has been the most significant development in China's gas sector. The project has driven new reforms and opened the sector further to foreign investment. If gas is to play a significant role in China's overall energy strategy, tens of billions of dollars will be needed to build additional transport and distribution infrastructure. Total costs will depend heavily on the policies China enacts and how successfully they are enacted. Chinese companies and municipalities would benefit by training experts in the latest methods of planning, regulating, and operating safe, efficient natural gas pipelines. Furthermore, the difference between wellhead natural gas prices and those paid by end-users is currently high and can be reduced by streamlining government authority and making distribution companies more efficient.

Downstream: Ensuring market demand for the newly available natural gas supplies is now the most important hurdle facing project developers. Wellhead prices for natural gas "within the plan" are currently set artificially low. "Out of plan" prices are far higher due to market distortions, inefficiencies, and, to some extent, difficult geology. The environmental benefits of natural gas should be included in energy pricing mechanisms in order to level the playing field among existing energy options. More research and development is needed to bring end-use technologies such as gas turbines, gas-to-liquids conversion, and fuel cells to market.

Recommendations for Further Collaboration

There are several promising areas for further collaboration between China, the United States, and other participants to overcome barriers in the natural gas sector. As in any successful collaboration, stakeholders need to be flexible and each must contribute something of value. The most promising opportunities are outlined below.

Business and Finance Training: China will need to train thousands of specialists over the coming decade if it is to boost natural gas use significantly. Especially valuable skills are those related to market-oriented management, finance, and regulation. Chinese natural gas specialists are often well equipped with analytical and technical skills, but lack skills in business planning and finance that help create successful business models.

The U.S. government could assist in the development of a training center in China that focuses on building market-oriented business and regulatory skills. A modest investment could lead to the creation of a permanent training center that becomes self-supporting after several years of operation. Chinese nationals who received training from international experts would staff the training center. Trainees would pay a modest fee to participate.

In addition to offering training in business skills, the training center could also build capacity in other areas to help accelerate development of China's natural gas sector. Three such topics include natural gas safety, pipeline operation and maintenance, and policy development. Chinese regulators will need to establish safety protocols to prevent accidents in newly built gas infrastructure from improper digging and end-use activities. The U.S. also has extensive experience it could share with China in planning, operating, and maintaining natural gas pipelines. Chinese specialists could be invited to visit facilities in the U.S. focusing in these important functions, but a more sustainable effort at the training center could leverage more powerful benefits. Finally, training could help high-level government officials develop a more comprehensive policy framework to ensure more rapid, coordinated action.

Technology Transfer: Chinese gas companies and end-users could lower costs by making greater use of new technologies. New developments in three and four-dimensional seismic imaging, data processing, and drilling techniques have increased the chances of finding exploitable gas supplies. In the United States, specialized service companies carry out many of these activities, but Chinese companies have yet to fully employ their benefits. End-use technologies including gas turbines, fuel cells, and gas-to-liquids (GTL) are of great interest to Chinese researchers, but need more attention if they are to play a significant role in the future economy.

Probably the most promising means of transferring these "hard" technologies to China is through joint venture or licensing agreements with foreign companies. The U.S. government would probably not assist in these maters directly as it cannot order private companies to transfer technology, and is not likely to buy the rights to the technologies so that they can be transferred. The U.S. could help bridge the gap, however, by helping identify barriers to the formation of such joint ventures and licensing agreements. It could also offer expanded scholarly exchange opportunities such as the International Visitors Program or Humphrey Fellowships to bring more employees from China's natural gas sector to the U.S. for advanced training.

Boosting Foreign Investment: Many foreign oil and gas companies would like to expand their business operations in China but have been constrained by both real and perceived barriers. Most of these companies have been encouraged by recent changes in China's gas sector, but claim that they could do much more if given the opportunity. Greater inflows of foreign investment would help China solve shortcomings in technology, finance, and management, although not without benefits for the investors.

Some barriers preventing greater inflow of foreign investment are generic to all foreign companies, like the claim that transparency is poor. Others are specific to the gas sector, such as the feeling among some companies that only very risky or poor quality development parcels are offered for exploration.

One of the most direct ways of boosting foreign investment would be to offer more exploration blocks and production sharing contracts, especially onshore, to foreign companies. Another would be to officially expand foreign investment and ownership in all pipeline and downstream projects. A final relatively direct method would be to allow more gas to be sold at market prices and loosen the allocation of gas to particular industries.

Other methods of boosting foreign investment are less direct and associated more with generic economic reforms. Enforcing laws according to contracts, publishing information on who holds final decision-making authority, and clarifying policy priorities would all help to lower the market risks perceived by potential foreign investors. The U.S. could help China create policies or institutions to accelerate the spread of these practices.

Policy and Regulatory Development: Chinese planners have experimented with a huge variety of reforms since beginning the move to a market economy. The U.S. could assist China in additional policy reforms related to expansion of the natural gas sector, but acknowledges that it is not in a position to tell China how to reform. If China chooses to further market reforms, U.S. specialists might be able to advise on issues related to policy, institutional, and regulatory development. The existing U.S.-China Oil and Gas Industry Forum has already considered some of these issues and may be capable of recommending advisors.