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CHINA AND LONG-RANGE ASIA ENERGY SECURITY: AN ANALYSIS OF
THE POLITICAL, ECONOMIC AND TECHNOLOGICAL FACTORS SHAPING
ASIAN ENERGY MARKETS

THE GAS DRAGON'S RISE: CHINESE NATURAL GAS STRATEGY AND IMPORT PATTERNS

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Introduction

Up until recently, debate and discussion of environmental issues in China has been confined to mainly environmental agencies and research institutes. The Chinese government institutions responsible for development of coal and oil-based industries have not considered environmental factors as a top priority in planning for future development of energy sources. Natural gas, as a cleaner energy source, accounts for merely 1.92 percent in the primary energy mix in China today, a proportion that lags behind natural gas use in both the major industrial economies and even many developing economies. By way of comparison, natural gas use covers 26.55 percent of energy consumed in the United States, 8.45 percent in India and South Korea and 4.27 percent in Brazil (BP, 1998).

The unprecedented floods of the summer 1998 and the growing problem of air pollution in major cities such as Shanghai and Beijing have forced the public and the central government to recognize the importance of environmental protection. A new awareness is emerging that clean energy sources must be utilized to maintain a sustainable social and economic development. China has moved once again to implement acceleration in domestic natural gas supply to meet the uprising requirements for cleaner energy sources. The country is also seriously investigating any possibilities of expanding its gas imports.

But the desire to enhance natural gas-fueled industry and consumer-use inside China faces several challenges. They are as follows: (1) domestic infrastructure and market networks are not sufficient to support the growing interest in natural gas usage; (2) substantial foreign imports face financing obstacles and also suffer from concerns about supply security risk.

This paper begins with a brief overview of China's economic development and the impact on energy demand and investigates the potential for and roadblocks to the wider use of

natural gas in the country. Focus then turns onto natural gas policy including potential domestic demand and supply, future import arrangements and the geopolitical influences that will affect its desire and ability to import substantial amounts of natural gas. The paper also investigates the various external sources of supply for gas to China and discusses the political implications of choosing one over another. Three technical notes are attached with data to support key findings.

A. Gas Track Under High Economic Growth in 1990s

China experienced double-digit economic growth in the first half of 1990s but this leveled off to 8 to 9 percent growth in 1996-98. The country faced serious problems during this period including high inflation in the latter half of 1980s and an economic bubble in the early 1990s. It took the central government more than five years to gently steer its economy to a more normal course with a low inflationary rate of about 3 percent. However, the Asian financial crisis has affected the country's economy this year. While China's currency is considered stable, economic growth is slowing. Chinese GDP growth was estimated 7.8 percent in 1998 (Chinese CCTV News Release, 1998/12/30).

Concerns remain about the future of the Chinese economy, including the anticipated rise in energy consumption that will accompany continued economic growth. China's huge 1.2 billion population and its high economic growth have created a rising demand for energy of over 5 percent during the period from 1986 to 1995 and rendered the country to be the second largest energy consumer in the world after the U.S starting in 1993 (BP, 1998). Coal represents 73 percent of total Chinese energy consumption, creating serious environmental damage. Chinese SO₂ and TSP emission standards are higher than that of the developed countries (Table-1).

1. Table 1

Table-1 Emission standards annual maximum emission permission ug/m³

	China	U.S.	Canada	Italy
SO ₂	150	80	60	80
TSP	300	150	70	150
NO _x	100	100	100	200

Source: The author's composition from various sources.

Forty-five cities' TSP and SO₂ among 88 surveyed are higher than the governmental standard (Hu, 1997). China was the third country in terms of CO₂ emission in 1990 and has been the second one after the U.S since 1995 (EIA, 1996). Three of ten most polluted world cities are located in China. They are Beijing, Shenyang in northeast China and Xi'an in the western China according to the World Health Organization's report in 1994. Environmental concerns are creating a pressure for the acceleration of natural gas supplies as a way to redress coal and oil-burning emissions.

China has significant potential resources of natural gas. There are 54 large and medium gas fields found over the past few years mainly in the Ordos, Sichuan, the Tarim, the Juggar, the Qaidam areas as well as in the western South China Sea. Exploration and production (E&P) activities from 1991 through 1998 resulted in newly added proven reserves totaling 853 billion cubic meters. Authorities believe additions of 100 billion cubic meters (bcm) per annum could be sustainable for the foreseeable future.

B. Challenges 2000-20

It has been projected that China would maintain its economic growth over 8 percent until 2010. Under this scenario, GDP per capita would be over US\$800 in 2000 and \$1500 in 2010. Meanwhile, population is forecasted to grow to 1.28 billion by 2000 and 1.42 billion for 2010, while the urbanization rate would be over 32 and 38 percent after the year 2000 and 2010 (CASS, 1997, see Table-2). The author believes the real economic growth rate may be lower if indicators are studied in terms of PPP (Purchasing Power Parities) as forecasted by Paris-based International Energy Agency experts (Ogutcu, 1998).

1. Table 2

Table-2 Chinese social economic development to 2010

	Unit	1995	2000	2010
Population	Billion	1.211	1.287	1.423
Urbanization	%	29	32	38
GNP growth	5	9.6	9.4	8.1
GDP per capita	USD	700	700 - 1673	1673 -2913

Source: CASS, 1997

An in-depth study of the natural gas sector in China showed that gas demand in China has been restricted in the past years (SPC, 1996). Liquefied Petroleum Gas (LPG) has been widely used in 600 cities while natural gas used has lagged and primarily been used in only about 50 cities near the Sichuan gas fields starting in 1989. Considering China's current environmental situation and future economic goals, there is a strong need to enhance the use of natural gas. High economic growth forecasted above will translate into at least 100 bcm

of additional natural gas demand in 2010 and 150 bcm in 2020 (see Appendix B-1). But this level of natural gas use faces several obstacles including a possible internal supply deficit, massive infrastructure requirements and lack of expertise and institutional frameworks for commercialization of domestic natural gas markets.

2. Gas Gap

It is expected that China can produce gas from around 255 fields including 9 large fields (reserves over 30 bcm), 45 medium fields (reserves between 30-10 bcm) and 209 small fields (below 5 bcm). Among them, 47 large and medium fields constitute 80 percent of the country's total gas output (Appendix A). Chinese rate of proven natural gas reserves is merely 5.91 percent while the world averaged at 59.3 percent. Incremental gas to 2020 is showed in Table-3 (see Appendix A-2).

3. Table 3

Table-3 Gas Output Forecast bcm

	Onshore	Offshore	Total	Peak output
2000	15.1-20.3	8.5-10	23.6-30.3	30
2010	40.6-47.5	22-26	62.6-73.5	70
2020	71.9-93.5	28.5-33.5	100-127	123

Source: Xu, China 99: Petroleum Upstream Statistical Review, 1997

In addition, as non-conventional source, Coal-bed Methane (CBM) resource is estimated 25 trillion cubic meters. There are several pilot CBM areas with 300 bcm reserves and 50-100 bcm production. Further development can be expected in the next decade. Even so, the Table-4 shows significant demand to 2020. The gaps between demand (Table-4) and

indigenous supply (Table-3) show 21-24 bcm in 2000, 46-73 bcm and 60-111 bcm. Please note that Chinese gas gap in 2000 is roughly equal to annual LNG exports (23 bcm) from Australia, UAE, Qatar, Libya and USA in 1997 or 20 percent exports by pipeline from Russian Federation. The level is close to LNG imports of Belgium, France, Italy, Spain and Turkey and larger than LNG imports of both South Korea and Taiwan. The Chinese gas gap in 2010 will reach or surpass current LNG imports of Japan (BP, 1997).

5. Infrastructure Bottleneck

Chinese gas pipelines totaled 9112 kilometers (km) in length with transporting capacity close to 10.5 billion cubic meters of natural gas in 1996. The Sichuan Petroleum Administration carried 86.5 percent of China's total gas turnover for the year. Eight oil and gas trunklines, 1009.88 km in length, were constructed during 1994-96. The Shaan-Jing gas line (from Shaan-Gan-Ning to Beijing) completed in 1997 is the largest pipeline in the country. It is an 868-km long pipeline with a diameter of 660 mm and maximum annual gas transport capacity of 2 billion cubic meters. The gas supply by pipeline will redress energy structure and improve air quality in Beijing. By 2010, Chinese gas supplies could double but infrastructure to transport this higher level does not exist to date. Moreover, China has no national natural gas pipeline grid, leaving the domestic market highly segmented.

About 50-bcm of natural gas imports have been planned to 2010 from neighboring countries, both by pipelines and LNG tankers. However, costly international pipeline links and coastal LNG receiving facilities must be put in place to make such imports viable.

6. Market Development and Utilization

The Chinese gas market is currently at a very nascent stage. Currently, gas supplies around 8 bcm out of 22 bcm are utilized for chemical (mainly manufacture of fertilizer). Gas-fired generation technology, gas fuel and residential and commercial usage are at their early stage

representing only 6 bcm and 2 bcm but present promising future. Guangdong and Sichuan provinces are promising marketplaces where growth of both residential and commercial usage and gas-fired generation are the faster than those of any other places (See Table-5).

7. Table 5

Table-5 The provinces with higher residential use and gas-fired generation

	1994	2000	2010	2020
	(1)	(1) (2)	(1) (2)	(1) (2)
Guangdong	6.5	12.3 3.4	30.0 53.1	60.4 83.8
Sichuan	5.7	10.7 5.5	22.8 24.5	44.2 42.9
Shangdong	2.3	14.7 2.8	38.2 8.6	69.9 40.5
Jiangsu	2.8	11.3 0.0	23.5 9.2	43.5 41.6
Shanghai	5.8	12 4.0	18.7 10.5	25.5 23.2

Note: (1) Residential and commercial usage; (2) Gas-fired generation

Source: SPC

C. Policy Preferences

1. Domestic Priorities

After long debate, China National Petroleum Corporation (CNPC) Group decided in January 1999 to shrink its oil production from 107.38 million tones (Mt), i.e., 2.14 million barrels per day (mb/d) in 1998 to 106.6 Mt or 2.13 mb/d, for 1999. The cut of 0.78 Mt, or 15,380 b/d, has become a focus of media coverage. Among the several causes behind the

reduction is the fact that the oil production in China has reached its ceiling of 160 Mt, 3.2 mb/d, by annum at \$14-15/bbl prices, although some oil politicians used to deny this ceiling in the past. The previous plan for 200 Mt, 4 mb/d, in the year 2000 has turned out to be unattainable according to the currently available economic resources. As a result of this, CNPC and Sinopec must relax output constraints on oil producers and petrochemical facilities and change their way of thinking if they want stay competitive in both domestic and international markets. Meanwhile, the limitations of the oil sector argues further for the prioritization of natural gas development.

Chinese policy shift toward focused natural gas exploration has uncovered a group of large and medium sized gas field discoveries in the Ordos, the Tarim, the Junggar and the Qaidam areas as well as in the South China Sea as mentioned. Those newly added reserves are located mainly in Central China and offshore. Natural gas reserves and production can be increased with intensive exploration and development activities in these strategic areas in the next decades, should China opt to acceleration of natural gas development and rationalize energy consumption toward this cleaner fuel. Current Chinese government plans call for natural gas production by the year 2000 of little more than 25 bcm or 30 bcm. More ambitious gas development would require a more wide-ranging policy that would promote gas-fired generation as well as residential and commercial consumption and initiate gas replacement in projects now slated for oil.

Strong economic growth in the Sichuan and coastal provinces like Guangdong and Shangdong is expected to contribute to rising Chinese demand for energy. To meet these regional demands, some gas pipelines in Xinjiang and from Sichuan to Central China's market have been planned. Downstream facilities will be initialized near gas consuming markets. Offshore gas landing facilities and LNG receiving facilities may be constructed in Shanghai and Guangdong.

It would be appropriate to aim for natural gas to meet about 8 percent and 10 percent out of China's primary energy demand mix in 2010 and in the period of 2015-2020. This would represent 100 bcm of natural gas production and 60 bcm of natural gas imports by 2020. Oil demand would then be decreased to 12-13 percent, hydropower 7.3 percent and nuclear 3.05 percent. However, coal will continue to be dominant around 65-67 percent. The change of the energy structure will be substantial and dramatic for China in the next decades although it remains lower than world average level in 1993. An acceleration of natural gas development and utilization can help China on several fronts. It will help enhance China's energy security by diversifying available supplies to meet China rising energy requirements. It will also improve the living standard and air quality in most major cities. Reasonably, gas policy should be viewed as an imperative to securing Chinese sustainable development. Unfortunately, the gas policy remains only partially implemented and conceptualized. More review is in need on matters of pricing, taxation and foreign participation. So far, lower gas price and a non-competitive gas pricing system are problematic. Western experiences will be helpful in developing new systems.

2. Open Policy

The Chinese gas industry has had international participation since its inception. China's gas sector will benefit from access to western technology and expertise. Since 1982, China opened its upstream sector to foreign investment by conducting four bid rounds for exploration acreage in the Chinese offshore. As of October 1997, some 126 contracts and agreements with value of \$5.38 billion had been signed with 67 companies from 18 countries. Promoted by foreign investment and self-operation, offshore gas production has grown almost six-fold since the opening to foreign investors and reached 3 bcm in 1998, almost half of which is exported by foreign investors according to production shared

agreement. Currently, the South China Sea is the intensive place of interests by foreign energy companies like Arco, Amoco and Shell.

Onshore oil bids started in 1985 when 11 southern provinces and autonomous regions opened up for Sino-foreign cooperation. Another 10 northern provinces and regions followed in 1992, which made the total area available for cooperation up to 2.5 million square kilometers. Thirty-seven contracts valued at \$1 billion have been signed for onshore international cooperation over the past decade. A few of foreign credit loans have been extended for the expansion of gas production capacity and the completion of some refining and petrochemical facilities.

D. China 2020-30

Natural gas, as a cleaner fossil fuel, will be widely explored and utilized as a "bridge fuel" to a non-fossil fuel time into come late in the 21st century-- for many countries. A drop in oil production and environmental pressures will force China to reevaluate a major fundamental change in its natural gas policy for the year 2000. In the author's opinion, the next policy shift will occur between 2020-2030 when Chinese gas policy will change its focus from development of domestic resources to a search for international supplies. China's economic growth is projected to reach around 6 percent per annum after 2010. GDP per capita will reach \$3000 in 2010 and over \$4000 in 2030. Meanwhile, population natural growth will be peak 1.58 in 2030, while urbanization rate will over 50 percent in the year 2030 (CASS, 1997). Meanwhile, oil production will continue to decline after 2020, if not before. Natural gas will then become a vastly more influential element in the country's energy policy for the next generation. By 2020, imports and overseas expansion of China's natural gas industry will play a larger role.

To satisfy domestic needs, CNPC unveiled a plan in the late 1996 aiming at development of 300 Mt oil equivalent (mtoe), 6 mb/d, by 2010, about one third mtoe (i.e., 1 mbd oil plus 50 bcm gas) of which will have to be found outside of China. To reach this end, China initiated a strategy to enter the international investment arena and expand its holdings abroad. The year of 1997 presented a milestone when CNPC signed 7 oil contracts with foreign energy firms and governments. So far, CNPC has won 14 contracts with possible reserves 400 Mt, more than half has come into operation. China's overseas oil strategy has focused first and foremost on neighboring regions including East Siberia, Central Asia and the Middle East. Also, China has to work together with fellow consumers in East Asia and Southeastern Asia to share energy resources within secure arrangements.

E. Gas Import Patterns

Based on the author's consistent study on Asian petroleum geopolitical atlas (Xu, June 1997), an Asian natural gas grid could simply pencil a line from the Russian Sakhalin oil and gas fields westward down to the Caspian Sea and the Persian Gulf. This huge gas resource belt (including Russia, Central Asian States, Iran and the other Arabian producers) accounts for 73 percent of the world total. Meanwhile, there is an emerging gas consuming rim land (including Japan, China, S. Korea, India, Pakistan and the other Asia-Pacific countries) to the East which accounts for 11.4 percent of world gas consumption to date (BP, 1998). China is both an emerging gas market and land bridge for regional gas shipment from West to East. The country's gas import patterns will, to a great extent, be characterized by its peculiar position on the atlas.

It is possible that there will be multiple transporting routes from the Siberia, Russian Far East and Central Asia to China. China has a two-pronged import gas strategy: (1) inland markets can be linked with domestic and international natural gas supplies by pipelines; (2)

southeastern coastal regional demand can meet growing energy needs by switching to LNG shipment by sea-lanes. Gas import patterns will be purposely diverse to secure and maximize various regional linkages.

1. Russian Gas Imports

China has expressed interest in seeing gas development in eastern Siberia. Russian gas imports to China are receiving serious attention in Beijing for several reasons. The geographic location of the Russian gas reserves provides a means to enhance gas supplies from Russia to Chinese northeast provinces and North China (Beijing, Tianjing and other provinces) and to secure Daqing oil output over 500 Mt per year, or 1 mb/d, through 2010. The import has several following pipelines routes proposed by Russia, China and other parties.

Irkutsk -- Mongolia -- Erlin -- Beijing -- Rizhao;

Irkutsk -- Mangzhouli -- Shengyang -- Beijing -- Rizhao;

Yakutsk -- Harbin -- Beijing;

Sakhalin and Yakutsk -- Khabarovsk -- Korean peninsula with a branch in Jilin province in China.

Among them, pipeline from Irkutsk with over 3,000 in length and 32 bcm import is hailed by China.

And all of these routes would cement Sino-Russian political partnership. By linking with gas exports, Russia recognizes China as a major geopolitical power in East Asia. Several strategic overtures of cooperation in gas E&P and transportation to China were initiated in 1989-96. Sino-Russian oil and gas pipelines projects with more than \$20 billion investment

requirements were signed in April 1996 as an element of Sino-Russian Strategic Partnership.

Russian gas supply has been called into question more recently due to the economic instability, political uncertainties and local governmental co-ordination in Russia. To secure the transportation, Russian gas reserves remain less supportable. It is likely that China will join gas E&P activities in Eastern Siberian gas fields and tighten its strategic tie with Russia politically. But this policy wouldn't mean that China would align itself with Russia. China has economic and political competition with Russia in other fronts, such as Central Asia energy resources. Rather, China would like to co-ordinate instead of confronting with Russia on Central Asian issues and alternative gas transit and sales routes. In sum, China has its choices and may trade-off between Russian and Central Asian sources.

2. Central Asian Corridor

Central Asia is both hinterland and midland in Eurasia. It was here where both Russia and Great British empires unfolded great confrontation or Great Game in the 19th century. Now multiple major powers are competing for hydrocarbon resource and transportation routes from the region. China came late to the game of participation in Central Asia. But it does have two development projects in Kazakhstan as mentioned. Aktyubinskneft is based in western Kazakhstan and has estimated oil reserves of 483 million tons. Current annual output of crude of about over 2 Mt per year, 40,000 b/d, would be double by 2010. CNPC has also committed hundreds of millions of dollars to enhance Uzenmunaigaz output to a higher level in the first decade of next century. Besides E&P activities, technological support and technical services were made active in Central Asia in the past two years. There are big potential service markets for Chinese technical service exports. Clearly, direct investment and technical inputs support Chinese oil and gas imports from Central Asia.

Turkmenistan would most likely be the major gas supplier from Central Asia to China. Such western gas imports of around 20 bcm will be indispensable to develop Chinese gas chemical and residential usage in Xinjiang and could be brought eastward to supply to eastern China and even to Japan though these distances are quite daunting. To competing with this supply possibility, Russian suggested a long pipeline from the western Siberia. To reduce the challenges and enhance its position, China has to extend its Central Asian land routes from Kazakhstan and Turkmenistan down to Northern Iran to link its Persian sources. Also, the country would be willing to join a transportation link from Kazakhstan to Russian European part or join E&P activities in Russian Siberia for its expected gas stake from East Siberia and Russian Far East. Consequently, Chinese E&P activities and technical services in Central Asia will play a critical role in not only cementing its import from central Asia but balancing its Russian and Middle Eastern sources as well (Xu, April 1997).

3. Arabic Passage

China's presence and relations with the Middle Eastern oil and gas producers has been relatively weak compared with Western industrial powers. However, Chinese oil imports from the Gulf and Africa, started in 1985, now accounts for over 50 percent of China's total imports since 1995. Oman, Angola, Yemen, Iran, UAE and Saudi Arabia are China's major suppliers. To penetrate Arab oil and gas market, Chinese construction services and technical supports have expanded into Kuwait, Iraq and several other Arab countries.

Chinese oil projects in Iraq and growing imports from Iran are now a priority in China. Chinese imports from Iran have risen from 0.1 b/d in 1991 to close to 60,000 b/d in 1997. A Chinese pipeline from the Kazakh Uzen oilfield to northern Iran and future gas cooperation with Iran will enhance the China-Iran tandem (Plamen, 1998). In addition, Arab producers are being encouraged to enter Chinese offshore upstream and downstream areas with intent

to make a petro-dollar counter-flow. Chinese-Arabic energy relations will consist of oil and gas shipments by sea, energy land pipeline connections and cross investment backed by progressive oil diplomacy.

4. Southern Gas Imports

Guangdong, Fujian, Zhejiang, Shanghai and Jiangsu provinces (GFZSJ's provinces) in the southern coastal provinces of China are the most vibrant and fastest growing consumers of energy in China. The potential natural gas demand for this coastal region has captured the attention of the international gas industry. Appendix C explains in detail the promise of natural gas demand in the southern provinces. The GFZSJ's GDP growth was 13-19 percent in the first half of 1990s and estimated 10-12 percent in the second, higher than national average level. It is possible that growth will slow somewhat in the first decade of 21st century.

As the economy develops in the southern provinces, growing demand for cleaner energy sources is expected to emerge. These provinces' demand for gas fire generation is projected to reach 10.8-18.6 bcm for 2005 and 20.2-35 bcm for 2010. Industrial and residential needs are projected 7.6 bcm for 2005 and 10.7 bcm for 2010. The share of gas consumption will be 5.4 - 7.7 percent of total energy mix in 2005 and 6.7 percent in 2010 in the provinces.

Given south China's great distance from domestic gas fields and other regional gas fields accessible by pipeline, Chinese offshore gas source and LNG imports from the Middle East and the Southeast Asian are feasible (see Appendix C-4, 5, 6, 7 and 8). The proposed \$5 billion Asian Gas Grid (AGG) project, recommended by the Business Advisory Council of APEC, has attracted interest from investors in both APEC and non-APEC countries. The AGG project is essentially a network of gas pipelines to transport natural gas from the Malaysian and Indonesian gas fields to major demand centers in China, Chinese Taipei,

Japan and Korea, using existing networks in Malaysia, Indonesia and Thailand (APEC web site).

Also, projects exist to bring about 15 Mt of LNG annually to meet rising Asia-Pacific market demand. China is now in the process of planning three LNG receiving terminals and landing delivery system on its coastal line on Yangtz Delta, Zhujiang Delta and E.S. Fujiang Triangle. Imports to these terminals could equal 3 Mt in 2010 and that volume could rise to about 10-15 Mt (equal to 27.6-34.5 bcm) by 2020.

China is now studying possible sources for LNG to sign long term contracts to meet this demand. Malaysia, Indonesia, Brunei and Qatar are currently favored as stable and reliable suppliers in the short term. In the longer run, there are many reasons to believe that China will link its southeastern coastal gas consuming markets with the Middle Eastern LNG sources such as Oman, Yemen, Iran, UAE and Saudi Arabia, signing long-term contracts for these supplies. At the same time, China's state oil companies might consider direct investment opportunities in LNG projects in the Middle East and Africa, depending on the economic conditions of such investment. It is certain that comparative economics shows us several feasibility studies with risks to bring natural gas by LNG or pipeline from Russia, Central Asia, Iran, the Persian Gulf (Qatar, Oman), and Southern Asia. Under current oil pricing, pipelines from the FSU are in check economically. A short gas transportation like offshore gas landing and flexible LNG import contracts are competitive. However, pipelined gas can't be ignored in the longer run. The final choice will not only be dependent on comparative advantages but up to changing geopolitical conditions.

F. Geopolitical Relations With Other Consumers

As the largest emerging market and land bridge in Far East, China will play an important role in linking energy suppliers in Russia, Central Asia and the Middle East. However, the

geopolitics of natural gas supplies be they piped from Central Asia and Russia or shipped by tanker from the Arab gulf suppliers like Saudi Arabia, Oman or Qatar will be different from the sensitive dynamic now seen in international oil markets. Natural gas pipelines or LNG programs entail huge investments that require a commitment to stable political relations and long-term energy relationships.

Chinese petroleum diplomacy should follow an integrated approach and become more aggressive to promote maximum market penetration in Central Asia, Russia and Middle East, especially where natural gas supplies are concerned. To this end, China prefers a balance of power. China and Russia could work together to counterbalance and confront the Western involvement in Central Asia. It is also important to prevent the West from exerting strong influence in the region. Or, it is possible that China might enhance its political ties with the EU and the US and lower its energy co-operation slant with Russia, if the West could handle Eurasian issues appropriately (Xu, April 1998). On the other hand, to secure its import patterns, China has to forge stronger ties with other regional gas consumers such as Japan and South Korea.

1. Cooperating With Northeastern Neighbors

There is a triangular relation facing China in East Asia. Japan, China and South Korea are top gas consumers in East Asia and account for 40.21 percent (BP, 1998) of the region's total consumption. The triangle across the Yellow Sea will be the biggest consuming area in Asia with huge gas importing requirements. Japanese and South Korean economic security are highly dependent on stability of foreign imports. These big three consumers have common interests in developing their links with gas producers. At the same time, the three have their responsibilities to secure stability and sustainability of their demands in the region which are now required by major petroleum exporting countries including the

Middle Eastern producers, Russian and southeastern Asians as exporters. Any over competition would be no good for all.

China is not only an emerging market but also a transport corridor to Japan and South Korea. Japan and South Korea realize China's position and the importance of utilizing Russian and Central Asian oil and gas sources. To reduce their geographical disadvantages, Japan and South Korea are actively investing in hydrocarbon resources in Russia and Central Asia on the one hand and are looking to cooperate with China in transportation on the other. China will need the financial support of Japan and South Korea to raise the massive capital for the transportation infrastructure while Tokyo and Seoul also short of natural resources would benefit from access to new oil and gas sources via China's land bridge.

Japan concerns about China interfering with the security of sea shipments of oil and gas along the South China Sea are unfounded. As matter of fact, any tension in the South China Sea will not only impact Japan and S. Korea but Chinese oil and gas shipments and the stability of China's badly needed supplies.

Right now, academic consensus and exchanges regarding the oil and gas market among China, South Korea and Japan are more common than official negotiations. The critical obstacles for the future cooperation are regional political and economic differentiation and military security arrangements backed by the third power. In addition, Korea and Taiwan are important passes on northeastern Asian petroleum market from Russia and the South China Sea. To ensure secure gas imports, China has to deal effectively with any insecurity and uncertainties derived from those regions. Cooperation on natural gas supplies will also mean a resolution of tensions in the Korean peninsular will have to be resolved. China has

played this important role in easing any tensions between the North Korean regime and South Korea.

2. Engaging With Southeastern Asian Consumers

Chinese offshore oil production on the Bohai Bay, Eastern China Sea and northern South China Sea would be peak in a few years to come. Chinese coastal demand for natural gas and potential LNG imports will force China expand its offshore gas E&P activities on the South China Sea and beyond. As a result, growing gas demands in southeastern Asia have held gas supplies available to China and southeastern Asian consumers in check.

To some extent, all the littoral countries of the South China Sea have strong economic interests in the potential offshore hydrocarbon resources that controversial waterway. Vietnam, the Philippines, Malaysia and Indonesia are emerging consumers like China. China's lack of political participation in regional issues and its weak bilateral relations with each of its southern neighbors has hindered the development of energy cooperation over the last decade or so. The quest among these littoral countries around the South China Seas for oil and gas resources requires mutual understanding and political cooperation. In recent years, China has played an important role in regional organizations such as APEC and it has shown significant support to southeastern Asian countries to assist them to weather the current financial crisis. Chinese policy on the South China Sea remains to separate economic interests from territorial disputes with intent to seek a practical solution to maintain regional cooperation. China also suggests that Asian states should hold regular official Central Bank meetings to cooperate against a repeat of negative financial interference and the risks of globalization.

Considering interdependencies and comparative advantages between China and its southern neighbors, China supports oil and gas development in Thailand, Myanmar and Bangladesh

in South Asia. Chinese oil majors maintain their presence in oil and gas trading businesses with Singapore, Malaysia and Thailand. India is the third largest gas consumer with soaring demand for gas source from the Middle East and Central Asia. China has some kind of competition with India and Pakistan for the same sources. As two important weights of Asian petroleum market, both China and India have a responsibility to work together to maintain a sustainable economic plan to favor the development of regional natural gas industries and secure supply of natural gas throughout Asia.

3. Adjusting Relations With Major Powers

To render its expected gas sources as secure, China has to weigh its choices among several sources and trade-off between Russian and Central Asian supplies. In either case, China has to cooperate with Russia strategically. Beyond the Asia-Pacific, China has also to realize the importance of relations with the West. The U.S. will not change its worldview and tries to balance its world-wide geopolitical strengths. The U.S. economy depends on more than 50% of its energy needs from foreign oil imports. The U.S. still considers the stability of supplies from the Middle Eastern supplies as critical to its vital interests. However, the U.S. market will increasingly be supplied by oil imports from South America and Canada, with only small amounts required from more distant regions. Still, newcomers might be translated into some kind threat or confrontation with the U.S. interests, particularly with regard to U.S. allies. At the same time, American input in Central Asia and the Caucasus region aims at an elimination of Russian possible dominance of Central Asia and the Caucasus. The US presence in East Asia and Southeast Asia is aimed with traditional goals: to protect American political and economical interests by defending and keeping stable international trade movements in the region. China's goals in the region (like its penetration in the Middle East and Central Asia) are to enhance its oil interests rather than political or military expansion. To balance American influence in Asia, it is widely recognized that

China and the EU could come closer politically and economically in the future. It is highly likely that the closer political and economic relations between China and the EU could yield energy, environmental and agricultural co-operation to a large degree.

Conclusions

Gas consumption has overtaken production in China. The gap will become larger as the country moves towards its economic goals in the coming decades. To bridge its rising demand with supply, China will continue to prioritize its domestic exploration and production before 2010. But gas sector no longer serves as a by-product or by-industry from now onwards given new requirements for environmental protection and enhancement of social welfare. Chinese gas industry is immature and characterized by an imbalance between resources and consuming centers geographically.

To satisfy its growing needs, China has to search for foreign gas resources and push to expand its available resources. Overseas priority will be given to its neighboring hydrocarbon provinces including the Central Asia, Russian Siberia, the Middle East as well as Southeast Asia. A new Silk Road, Sino-Russian energy partnership and China-Iran tandem will play a complementary role in securing Chinese import requirements. Of course, China has to bear huge investment and uncertainties to accomplish the benefits from overseas ventures. It is wise for China to get closely involved in cooperation with its neighboring consumers and reconcile with the other powers.

In turn, the world should re-evaluate China's economic and geopolitical role in global energy marketplaces and balance of power relations. The author believes that by 2020-30 fundamental change will create a shift of China's current inward energy policy toward a fundamentally internationally oriented policy. Overseas gas expansion will be developed as a national priority.

In short, the future gas supply deficits would be looming large and create an unprecedented challenge for China's sustainable development. A shift to domestic priority toward natural gas resource development and a more prominent emphasis on international cooperation can be expected to emerge from China's energy policies for the next decades. Major change from oil to gas could occur by around 2020-30, which will be a milestone for the country and have substantial impact on Asian and global economic sustainable development.

Appendix A: Chinese gas resources and production

1. Proven reserves

More than 150 sedimentary gas bearing basins in were confirmed in China in the first half of the 1990s. According to assessments on 69 of the 150 basins, conventional gas resources were projected to be about 38 trillion cubic meters (Tcm), 78.75 percent of which is on land and 21.25 percent offshore.

More than 65 percent of total reserves are located on strategic areas such as Tarim, Sichuan, Ordos, Junggar and offshore (mainly Bohai Bay, the South China Sea and the East China Sea).

A-1 Five Major Gas Areas (Tcm)

Gas regions	Tarim	Sichuan	Ordos	Yange	E. China Sea
Volume	8.3896	7.3575	4.1797	2.239	2.4803
Percentage	22.07	19.36	10.99	5.89	6.52

Source: Wan, 1996; Hu, 1997

Assessing China's proven gas reserves is a challenge due to conflicting in-house geologic surveys. CNOOC expert (Prof. Wang Shanshu) previously projected that proven offshore gas reserves amounted to 1.39-1.59 Tcm, while CNPC experts (Prof. Wan Jiye, 1996 and Hu, 1997) projected them to be 6.90-13.2 Tcm. The national reserves averaged 11 Tcm.

There are over 255 gas fields, including 9 large fields with reserves above 30 bcm, 45 medium fields with reserves between 10 and 30 bcm and 209 small fields with reserves below 5 bcm. About 47 large and medium fields constitute 80 percent of the country's total

gas output. Gas output from the Sichuan basin, accounting for 36 percent of the day, plays an important role in maintaining national supply.

2. Reserve projection to 2020

There are two approaches to project future reserves: the Gray System and Wen Spiral Projection. Based on both approaches, Chinese gas proven rate is merely 5.91 percent so far while the world averaged 59.3 percent. By the year 2020, Chinese gas proven rate could be 22 percent and proven resource 8.15 Tcm. The peak of Chinese gas reserves will occur around the year 2020. Attached below are gas reserves forecasted to 2020.

A-2 China's Onshore Gas Reserve (bcm/y)

Proven rate %	1995-2000	2000-2010	2010-2020
30	133.8	172.65	177.45
40	151.5	201.7	222

A-3 China's Offshore Gas Reserve by Prof. Wang (bcm)

Regions	1996-2020	2001-2010	2010-2020
Bohai Bay	30	50	50
E. China Sea	20	50	40
Western S. China Sea	300	360	200
Total	350	460	290

3. Production projection to 2020

An approach of a "Resource-Reserve-Production (RRP) linkage has been employed here to forecast gas output to 2020.

A-4 Onshore Gas Production to 2020 (bcm)

	1995	1996-2000	2001-2010	2011-2020
Annual output	16.76	15.1-20.3	40.6-47.5	72.9-93.5
R/P rate	36	48-40	33-31	26-21

A-5 Offshore Gas Production to 2020 (bcm)

Region	1995	2000	2010	2020
Bohai Bay	0.4	1.1	2	3-4
E. China Sea	--	0.4	2	2-3
W. S. China Sea	3.57	6.5-8	16-20	20-23
Total	4	8-9.5	20-24	25-30

Combining the data from CNPC, CNOOC and CSPC (China Star Petroleum Corporation), we get the following summary of gas output for the country:

A-6 National Gas Production Projection (bcm)

	onshore	offshore	Total	Peak output
2000	15.1-20.3	8.5-10	23.6-30.3	30
2010	40.6-47.5	22-26	62.6-73.5	70
2020	71.9-93.5	28.5-33.5	100-127	123

In addition, coal bed methane (CBM) resources are estimated to be 25 Tcm or more. Currently, there are between 3 and 5 pilot areas with reserves of 300 bcm control reserves

and outputs of 50-100 million cubic meters. As a new source of clean energy, CBM has strategic significance to redress China's energy demand and supply imbalance, improve its coal dominant energy structure, and protect the environment.

Appendix B: Gas consumption and segmentation

1. Present consumption

Chinese gas demand is a hot topic, in part because current gas consumption is from diverse sources and at low levels. Consumption of 1995 was 31.5 bcm in total, comprised of 60.5 percent natural gas, 18.2 percent LPG and 20.6 percent coal gas. Since 1989, LPG consumption grew rapidly and widely in 600 cities while natural gas usage remains stagnant and primarily used by about 50 cities near Sichuan oil and gas fields. Chinese demand for natural gas as a whole has been constrained by a shortfall in supply. However, the study by the State Planning Commission SPC Energy Institute indicated that current consumption structure by no means implies less demand for natural gas in the country. Instead, it argues that natural gas consumption was soaring between 1996 and 1998 and reached approximately 200 bcm by 1998. Considering the current environmental situation, future national economic development and enhancement of the standard of living, natural gas is seriously needed.

2. Projection models and results

B-1 Chinese natural gas demand forecasted to 2020 (bcm)

Projection Models	1995		2000		2010		2020	
	low	high	low	high	low	high	low	high
Gray system	19.23	19.74	32.1	35.68	76.42	99.13	115.4	155.8
Elasticity I	26.5	29.7	46	58	123.8	156.6	261.5	332.8
Elasticity II	28.7	32.7	54.1	70.2	140.6	183.8	287.1	378.1
Leap Model	25.6	27.4	33.82	37.45	82.85	98.47	126.5	163.7
Medees	35.32	37.17	55.39	59.09	113.4	127	154	187.7
Mix	25.96	30.8	44.67	54.56	108.6	146.56	161.01	238.51

Source: SPC's Energy Institute, 1997

The driving forces behind this pattern are high economic growth, population and environmental concerns. Compared with the current structure, energy mix and regional demands will have changed fundamentally by 2020.

(i)B-2 Energy mix percentage

1994					2020				
gas	oil	hydro	unclear r	coal	gas	oil	hydro	unclea r	coal
1.9	19			74	9-11	7.4	7.9	3.3	64-69

Source: Hu, 1997

(ii)B-3 major consumers

3. Demand segmentation

3.1 Residential consumption

The following data shows current gas consumption by sector in 1997

B-4 Sector consumption percentage

It was verified that natural gas accounts for 41.3 percent of total gas consumption in terms of thermal unit.

B-5 Gas type of consumption

Chinese economic growth hovered between 6 and 7 percent, with a rapidly rising urbanization ratio of 50 percent in 2020 while city residential gas implementation averaged 85 percent.

B-6 National residential demand (bcm)

3.2 Gas-fire generation

Gas fired generation accounted for 3.7 percent of total consumption in 1994 and 14.7 in 1997. In terms of power generation, gas fired accounted for 1.2 percent in 1997. However, gas generation remains premature compared with other developing countries such as India, where gas generation was estimated at 7 percent of power generation in 2000. Various projections present a promising future in terms of GkWh (table B-8).

B-7 China's power generation in 1995 GkWh

B-8 Chinese future generation to 2020 GkWh

Among them, gas fire generation will be 20.75 GkWh, 153.97 GkWh and 307.2 GkWh in 2000, 2010 and 2020, costing natural gas 31.45 bcm and 62.78 bcm in 2010 and 2020. Currently, ten provincial governments (including Beijing, Tianjing and Shanghai) have either planned or have been constructing plants: four LNG plants and six gas fire power plants. The SPC estimated that eight of the ten provinces will aim for an LNG rate of about 28 bcm, half of which will be used by generation.

3.3 Gas chemical

Currently, there are 183 sets of gas chemical facilities with annual capacities of 6 Mt. However, 92 percent of gas is used for fertilizer. In the next decade, the Chinese gas chemical industry will be boosted in Sichuan, Xinjiang, the Shanggannian region, the city of Daqing and the Hainan provinces. The gas chemical outputs are estimated as follows:

B-9 Gas chemical output forecast

3.4 Gas vehicle

Last but not least is industrial gas usage. In this context, gas vehicle (NGV) stands out as an environmente friendly and a cost-effective method. Since China is an emerging vehicle market, it is logical that the volume of vehicle has grown 15 percent in the past decade, including gasoline consumption of 34 Mt and diesel consumption of 51.21 Mt in 1997. Gasoline and diesel demand will soar to 72 Mt and 120 Mt, respectively, by 2000. Oil supply and environmental concerns make this trend dangerous and constitute a great pressure on gas. As SPC planned, China will have 0.1 million gas vehicles in 2005 and between a half million and one million vehicles by 2020 using gas 4.5-10 bcm with replacement of 110 million tons of oil imports.

Appendix C: Pipelines and LNG Imports

1. Introduction

As appendices A and B show, Chinese gas demand will be increasing to around 200 bcm by 2020 while domestic gas output will be 97-120 bcm. The gap between demand and supply would be about 80 bcm, which must be bridged by outside sources. It is also well recognized that the former Soviet Union (FSU) and the Middle Eastern natural gas reserves account for more than 72 percent of the world total listed below. Fortunately, theoretically speaking, they are accessible to China through both land and sea routes.

C-1 World Major Gas Producers in 1997 (Tcm)

Therefore, how to utilize the possible foreign sources both by land and sea routes is a key issue facing China its overseas strategy.

2. Pipelines links

2.1 West Siberia

There are about 95 Tcm of possible gas resources in West Siberia including the Yamal Peninsula, Barents and offshore near the Kara Sea. Ventures beginning in 1934 have resulted in the discovery of more than 300 oil and gas fields. Among them are 7 giant gas fields with proven reserves over 1 Tcm and more than 20 major gas fields with 100 bcm reserves. Current annual gas output reached 550 bcm with a proven rate of about 46.9 percent. Its output is estimated to be over 600 bcm in 2000 and 890 bcm in 2010, largely coming from Barents and Kara Sea. Gazprom, a Russian gas giant, and other oil and gas companies have proposed a long distance pipeline from Novosibirsk in the W. Siberia to Shanghai in East China.

2.2. The East Siberia and Russian Far East

The oil and gas E&P activities in the E. Siberia began in 1930, with oil and gas first being discovered in 1950s. Cumulative natural gas reserves are estimated at 590 bcm. Russians found oil and gas in Russian Far East region (Yakutsk Republic and Sakhalin basin) later. Since 1976, four major oil and gas fields in the E. Siberia and its Far East region have been producing 1.73 bcm and will be up to 14-19 bcm in 2005. There are four exporting routes proposed and currently under consideration by Russia, China, Japan and S. Korea. These routes play key roles in securing Chinese gas supplies. Irkutsk pipelines with over 3,000 in length and 32 bcm imports are hailed by China.

Irkutsk -- Mongolia -- Erlin -- Beijing -- Rizhao;

Irkutsk -- Mangzhouli -- Shengyang -- Beijing -- Rizhao;

Yakutsk -- Harbin -- Beijing;

Sakhalin and Yakutsk -- Khabarovsk -- Korean peninsula with a branch in Jilin province in China.

2.3. Central Asia (Turkmenistan)

Turkmenistan, Kazakhstan and [Uzbekistan] are rich in natural gas resources. Turkmenistan is especially rich, with 13.5 Tcm in gas resources and 2.7 Tcm in proven reserves. Its production was maintained at 80 bcm in 1980s and declined to 16.1 bcm in 1997. Its domestic demand in 1997 was 7.8 bcm. In spite of declining production, international energy experts are optimistic about future export potential from Turkmenistan. In 1993, the Japanese company Mitsubishi opened an international pipeline from Ashkabad in Turkmenistan, which crossed China to Japan. China and Korea are supporting the line. However, considering the geopolitics of energy and the pipeline in Central Asia, the

pipeline remains under study to determine its feasibility. Ashkabad may decide that it is not the right time to prioritize its east bound line.

2.4. Asian Gas Grid

The APEC Energy Working Group is calling for removal of impediments through policy changes within APEC economies to foster a favorable investment environment. Building on this initiative, the Asian Gas Grid Project is taking this further by setting up the APEC Resource Corporation to coordinate the development of an Asia-Pacific gas network. The network would link existing and proposed gas networks in Indonesia, Malaysia and Thailand with major markets for consumption in China and possible expansion to Chinese Taipei, Japan and South Korea.

3. LNG sources and routes

3.1. Growing Coastal demands for foreign sources

In appendix B, Chinese future demand for gas to 2020 was analyzed. Listed below are Coastal provinces demands:

C-2 Coastal Region Gas Demands (low scenario) (bcm)

Note that Guangdong, Fujian, Zhejiang, Shanghai and Jiangsu provinces (GFZSJ) are the most vibrant and fastest growing consumers. The GFZSJ's GDP growth was 13-19 percent in the first half of 1990s and estimated to be 10-12 percent in the second, higher than the national rate, and will level off a bit in the first decade of the next century. Economic trends create a huge demand for gas. Their demand for gas-fired generation was estimated at 10.8-18.6 bcm for 2005 and at 20.2-35 bcm for 2010. Industrial and residential needs were projected to be 7.6 bcm for 2005 and 10.7 bcm for 2010. The share of gas consumption will be 5.4-7.7 percent of the total energy mix in 2005 and 6.7-10 percent in 2010. The

following table shows gas demands in Zhujiang Delta, Yangtz Delta and E. S. Fujiang regions.

C-3 Three Areasí Gas Demands (bcm)

Currently, these coastal areas are encountering the following challenges:

- Shortage of supply
- Limited hydro power potential
- Long distance coal transportation
- Environmental concerns about emissions from coal burning

Searching for a cleaner source of energy has created a solution and a way of eliminating the bottlenecking effect of infrastructure. There are three sources available for the coastal markets. They are (a) Chinese offshore gas landing supplies; (b) a pipeline source from Russia; and (c) LNG and LPG imports. It is clear that inland pipeline sources would be difficult because of geographical concerns. Chinese offshore gas landing and LNG import seem to be more feasible.

3.2. Chinese offshore gas production

Chinaís offshore gas E&P started in 1983 when China opened its offshore for international participation. There are 41 oil and gas bearing geological structures in Bohai Bay, the East China Sea and South China Sea.

C-4 Chinese Seas Gas Production (bcm)

The importance of the South China Sea will increase because of the development of the Chinese gas industry. As CNOOC planned, Chinese offshore gas production has been

increasing since 1992 with a target 10 bcm in 2005. Unfortunately, the limited landing supply is far from satisfying the coastal provinces' needs addressed above.

C-5 Chinese Offshore Gas Production (bcm)

There are two major LNG markets - European markets with supplies coming from the Middle East and North Africa and the Asia-Pacific market with supplies coming from Australia, Indonesia, Brunei, Malaysia, and the Middle East. The Asia-Pacific market accounts for 74 percent of the world's total LNG trade. The Asian-Pacific market has been growing constantly and will have expanded by more than 150 bcm in 2010 when Thailand, India and China become major importers. China's future gas imports by sea are mainly dependent on the Asian-Pacific market (Indonesia, Malaysia, Brunei and Australia) and the Middle East (Iran and Qatar).

C-7 Extended LNG Projects Toward Far East Markets in 1990-99

C-8 Grass-root LNG Projects Toward Far East Markets After 1998

The projects will produce a combined 5 Mt of LNG annually to meet market expansion in the Asian-Pacific market. China is now in the process of planning three LNG receiving projects and a landing delivery system on its coastal line in Yangtz Delta, Zhujiang Delta and E.S. Fujiang with total imports of 3 Mt in the short term. About 10-15 Mt (equal to 27.6-34.5 bcm) LNG imports will be required for the year of 2020.

4. Challenges

In terms of gas transportation, the Chinese gas pipeline has been extended to 10020 km in length with a transportation capacity of 15 bcm, of which about 55 percent is concentrated in the Sichuan basin. Short distance and small diameter pipes are found in the north and northeast regions. China's gas transportation is characterized by local pipelines, shortage of

delivery systems, low pressure and short distance, and fewer major storage switches (e.g., underground storage facility). Diverse forms of national gas transportation (pipeline, LNG facility and vehicle) with T-form connections with international sources have been planned.

- At the turn of the century, China's gas output will be around 30 bcm. The domestic transportation from central and western China's gas to the eastern and southwestern markets will be the top agenda. Shipment of gas from the Ordos gas field to Xián, Yanchuan, Beijing and Tianjin will be prioritized. Meanwhile, transportation within Xinjiang will be initialized. In addition, about 6 bcm gas shipment capacity from the E. China Sea to Shanghai will be completed by the end of the century. The total pipeline will be extended 4257 km with an investment of \$8.21 billion.
- It is estimated that gas output will be 66-77 bcm, largely coming from West China, in 2010. The gap between demand and supply will be 20 bcm. The total domestic pipeline will be extended by 9258 km with an investment of \$13.4 billion. There will be two international gas delivery pipelines that will be constructed on China's side with investment about \$4.42 billion. LNG import will be 10-35.5 bcm in 2010.
- In 2020, China's gas output will be 97-120 bcm. The gap will increase to 80 bcm. The total domestic gas pipelines (from West, Central and offshore) will be extended to 7567km with investment \$8.15 billion. Starting from 2010, gas imports from Russian Siberia and Turkmenistan will commence with an importing volume between 40-45 bcm. The remaining deficit will be filled by LNG imports costing about \$12 billion.

By and large, by 2020, China's nation-wide gas delivery system will be constructed and connected except to Lahsa, the provincial capital of Tibet, and to a few coastal cities. The investment for this infrastructure is estimated to be \$45.7 billion. The large imports and

huge investment requirements constitute a great challenge for the country's gas strategy and geopolitical interactions.

Conversions and Abbreviation

1. Conversion ratio

USD1=CHY8.3

1 Ton=7.3 barrel

2. Abbreviation

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