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Asia Natural Gas Asia's Natural Gas Industry in the 21st Century By Anthony Connerty

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Contents

Page

Abstract

Ι	Introduction	3
II	Background	4
III	China's Energy Needs	4
IV	Energy Shortage, Pollution and Alternative Fuels	5
V	Transportation	11
VI	Some Proposed Developments	12
VII	Conclusions	13

Table

Asia Natural Gas

Asia's Natural Gas Industry in the 21st Century

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Abstract

China's rapid economic growth has placed a strain on its energy resources. She has moved from being a net oil exporter to a net oil importer.

China's major energy resource is coal. However, coal means pollution.

China is not alone in facing these problems. Other countries around the world, including America and Britain, may be heading towards an energy/pollution crisis.

China, like other nations, is looking at gas as an alternative fuel. This little used energy source - 2% used in China compared with coal's 77 % - has the additional benefit of being a clean fuel.

Gas from different sources and in different forms - natural gas, coalbed methane, methane hydrate, LNG, LPG, GTL and "gas by wire" - is comparatively plentiful. But one of the problems with gas - particularly in China - is transportation. The resource tends to be located in remote areas far from the high energy - user industrial and commercial areas like the coastal cities of China. And pipelines are expensive.

Is there a solution?

The different forms in which gas is used, like LNG and GTL, may provide an alternative to the high cost of constructing gas pipelines.

Because it is both an alternative fuel and an environmentally friendly clean fuel, gas may prove to be China's fuel of the 21^{st} Century.

I Introduction

This Paper seeks to look at China's energy needs, its energy shortage, the problem of pollution - and then at possible solutions to those problems.

Section II looks briefly at the historical background, leading on to a consideration of China's energy needs in Section III.

Section IV looks at the two related problems of China's energy shortage and pollution. Then follows a consideration of a possible solution: the use of gas as an alternative fuel to oil and coal.

That Section looks also at the world energy crisis: because the problems which China faces are faced by other countries around the world. Two examples are taken: America and Britain.

Section V considers a problem which, in China as in other countries, is linked to gas: transportation.

Two developments proposed in mid 2001 give some idea of the direction in which China is moving in relation to gas: a \$18billion gas pipeline and an LNG Import Terminal. These are considered in Section VI.

Finally, Section VII attempts to draw some conclusions.

II Background

China is said to be the oldest oil producing country in the world.

An oil and natural gas field was exploited in about 211 BC near Chiliuching in the province of Szechuan. Natural gas produced in that province about 1900 years ago was used as a fuel for the evaporation of salt lakes near Tuchiangyen.

Prior to the foundation of the People's Republic, China's natural gas resources were being used for both domestic and industrial purposes. Natural gas produced in 1947 was put at about 55million m³. This production was believed to remain steady until 1958, when a number of new natural gas deposits were discovered.

By the 1970s, natural gas was being produced in about 20 provinces throughout China, the most important reserves being in Szechuan province¹

By the end of 1993, 4,800 miles of natural gas grids had been built and 9.77billion m³ of natural gas were transported.²

III China's Energy Needs

Various predictions have been made about the growth of China's economy. Some say that China will have the world's largest economy by 2020/2025.

One obvious difficulty caused by China's rapid economic growth is the increased use of its energy resources. After America and the former Soviet Union, China is the world's largest consumer of energy.

China's primary energy resource is coal. China has the world's highest production of coal, which provides nearly 80% of China's energy needs.

Approximately 19% of China's energy output is from its oil resources. In 1998, in order to speed up the development of oil and gas projects in China, the Government divided the country into two geographical areas, each with its own Government organisation responsible for both upstream and downstream sectors. The China National Petroleum Corporation (CNPC) was to administer the north east and north west, and China Petroleum Corporation (Sinopec) was to cover the south east and the coastal region down to Guangzhou³

Something like 90% of China's oil is produced onshore, mainly by CNPC. Foreign investment has been encouraged, and by 1996, 30 contracts worth \$770million had been entered into by foreign companies, including Exxon and Shell.

Annually, only 2% of China's domestic energy production comes from natural gas⁴

¹ Wolfgang Bartka "Oil in the People's Republic of China", C.Hurst and Co, London, 1975:pp.12,45-47

² Anon Pipe Line Ind., November 1994, 77(11),45-48 "China's Oil, Gas Pipelines offer opportunity to outside firms".

³ Petroleum Review (the Journal of the Institute of Petroleum, London) November 1999, p23

⁴ The Guide to World Energy Privatisation, Arthur Andersen: "Energy sector growth vital for further economic development", Jones, D'Andrea and Rodriguez, p48

Interest has increased in offshore gas exploration. Arco's Yacheng 13-1 Field, south west of Hainan Island, was in 1999 producing nearly 90% of China's 372million cf/d offshore gas production. The predicted increase in gas consumption in China is from 22billion m³ in 1998 to 80b m³ by 2010.

Offshore developments coming on stream in the late 1990s included the Ping Hu Field in the East China Sea and the Qikou 17-1 in Bohai Gulf. Ping Hu was estimated to have recoverable reserves in excess of 200billion cf of gas.⁵

Estimates by CNPC project a doubling of the annual gas production by 2005 to more than 30billion cf. The bulk of this estimated growth is centred on recent discoveries in Western China.

The major existing and future gas production areas in China, as given by the World Bank, are set out in Table $1.^{6}$

IV Energy Shortage, Pollution and Alternative Fuels

This Section deals with energy shortage, pollution and alternative fuel sources..

The three are linked.

China is short of oil. Coal is still China's biggest energy resource. But coal causes pollution. Alternative fuels - and in particular gas -could help to solve not only the oil shortage but also the problem of pollution.

Linked to energy shortages, pollution and alternative fuels is a fourth element: transportation (dealt with in Section V). Although gas might help to resolve both China's energy shortage and its pollution problem, gas invariably raises transportation problems.

In relation to those four factors - energy shortage, pollution, alternative fuels and transportation - it is perhaps useful first to look at the global situation: because China is not alone in relation to the difficulties which it faces.

(1) World Energy Crisis

Many countries around the world are facing similar problems to China. Two examples are America and Britain.

In America, the average price of petrol is expected to reach \$3 a gallon in the summer of 2001, the highest price since the Arab oil embargos in the early 1980s. That forecast heightened fears that the United States was heading for an energy crisis.⁷

Indeed, on 18th May 2001, President George W Bush warned Americans that they were facing serious energy problems. He proposed a vast array of remedies, some of them radical: for example, creating a national electricity grid. Probably one of the Report's most controversial proposals was its support for nuclear power.

⁵ Petroleum Review, November 1999, supra, p24

⁶ World Bank Discussion Paper No: 414: "Liquified Natural Gas in China ": Girdis, Tavoulareas and Tomkins, p26. World Bank Washington DC, 2000. ISBN0-8213-4734-9

⁷ The Times, 8^{th} May 2001

The level of gasoline prices was less of a problem than the economic disruption being caused by persistent electricity blackouts in California (which were predicted as likely also to spread to New York.)

The remedies proposed were contained in a Report produced by the American vice-president's Task Force. The 163 page Cheney Report contained 105 recommendations, 12 executive orders, 73 directives to federal agencies and 20 proposals for congressional action.

America's main alternative energy source is coal. This generates about half of the US energy supply but is - as in China - an energy resource which causes pollution. America has 250 years worth of reserves of coal. The US Government proposes to spend \$2billion on cleaner coal - burning technology.

The Report also suggested building, in conjunction with Canada, a pipeline to bring Alaskan gas to the lower 48 US States.⁸

In Britain, in early 2001, there were concerns in relation to the supply of natural gas. Although Britain has considerable supplies of natural gas, the fear was that the demand for gas was growing at almost twice the rate of the economy. Britain therefore may have to look elsewhere. Norway is one possibility. Russia is another: Gazprom, the Russian State Gas Company, has "*the greatest gas bubble the world has ever seen*".⁹

Off the Norweigan Coast is the Asgard B, the largest floating gas platform in the world. Three fields in that area, where Statoil is the operator, are estimated to have recoverable reserves of 830million barrels of oil/condensate and 7.9 trillion cf of gas.¹⁰

Gazprom is the old Soviet Gas Ministry. It controls a quarter of the world's known gas reserves, and is the largest natural gas company in the world. It owns the world's largest gas pipeline system. The International Energy Authority estimates that gas will account for 62% of European energy consumption by 2020. Two thirds of that will come from Russia.¹¹

China's energy shortages - and its problems in relation to pollution - must be viewed against the background of a worldwide energy crisis which is affecting countries like America and Britain.

(2) China's Energy Shortage

China's economic growth has put a great strain on its energy industries.

From having been a major exporter of oil in the 1980s, China has now become a net importer of energy, particularly oil.

Shortage of oil means that the supply of electrical power in China has failed to keep up with demand. And shortage of power means idle factories.

⁸ Financial Times "Heat and Light" by David Buchan and Nancy Dunne, 18th May 2001

⁹ The Times 23rd March 2001

¹⁰ Petroleum Review, October 2000: "Asgard Gas Production" pp 32/33

¹¹ *The Times, 31st May 2001*

(3) **Pollution**

Coal is by far the largest primary energy resource in China: almost 80% as against oil at 20%.¹²

But coal means pollution. A switch to alternative energy sources - particularly gas - would go a long way to solving both China's energy shortage and the serious problem of pollution.

The effect of high energy consumption on pollution is shown by figures issued by the World Bank in 1996/1997. The cost of air and water pollution damage to human health in China could have been as high as US\$54billion a year: almost 8% of the GDP in 1995.

The State Power Corporation requested World Bank assistance to assess the viability of imported LNG as a fuel source for coastal provinces. The World Bank Report concluded that the competitiveness of gas as an alternative fuel "......is the principle determinant of its long term -market demand not only in the Yangtze Delta but also in China as a whole. In most geographic areas and uses it will compete directly with coal. At present, domestic gas may compete in areas where it can be produced economically, and imported gas may compete in areas where alternative energy sources are unavailable. While they are prohibitively expensive, air pollution dictates the use of the clean fuel".

On that basis, the Report concluded that the projected demand for gas in China is greatest in three geographic/demographic areas, namely, areas of high energy demand growth, areas with limited access to domestic coal supplies and where prices approach international levels, and areas with high levels of air pollution.

The Report identified various locations in which these three characteristics exist. These include Beijing and the coastal cities of Hong Kong, Shenzhen, Guangzhou, Shanghai, Hangzhou, Nanjing, Qinqdao and Tianjin.¹³

(4) Gas: an alternative fuel

Natural gas is an ideal fossil fuel. It is clean and convenient to use.

Worldwide, researchers are studying how natural gas was formed. It has been found not only in pockets by itself but very often with oil. Indeed, oil and gas often flow to the earth's surface from the same underground formation.

Natural gas is found in different types of underground formations, including shale formations, sand stone beds, coal seams and deep salt water aquifers.

Coalbed methane gas, found in all coal deposits, was at one time regarded as a hazard to miners. Research now shows that coalbed methane is in fact a valuable potential source of gas.

In the United States, the Department of Energy has funded scientists who are studying the causes of another type of gas: methane hydrate. This is found in deep ocean beds, or in cold areas of the world such as the North Slope of Alaska or Siberia in Russia. Methane hydrate is a tiny cage of ice, inside which are trapped molecules of natural gas.¹⁴

This Section looks at gas in the different forms in which it is used worldwide. Some of these forms are relevant to the problems of transportation.

¹² Arthur Andersen, supra, p121-124

¹³ World Bank Discussion Paper, supra, pp.3 & 15

¹⁴ US Department of Energy: "Fossil Energy: natural gas - fuelling the blue flame"

Natural Gas

China

China's plateau of gas output is estimated to range between 110 and 130billion m³. However, at present China produces only some 22billion m³ of natural gas. There is clearly a tremendous potential for development, and China's future for its natural gas consumption looks good. This will have the twin benefit of supplying energy for the country's continuing economic growth and at the same time providing a means of dealing with the problem of pollution. Natural gas, unlike coal, is a clean fuel.

China sees natural gas as a major industry.

The Chinese Government plans to boost gas consumption from the current 24billion m^3/yr to 50billion m^3/yr in 2005 and to 100billion m^3/yr by 2010.

The plan involves enormous capital investment and will offer opportunities to both Chinese and foreign investors. These opportunities range from natural gas exploration and development to such downstream operations as gas utility services.

One major aspect of the natural gas developments will involve the construction of pipelines on a massive scale.¹⁵

Worldwide

China's interest in natural gas is reflected elsewhere in the world: nearly 10,000 miles of new mainline gas pipelines are constructed each year.

In the North Sea, the Inter-Connector gas pipeline links the gas grids of Britain and Belgium. The pipeline became operational in October 1998 and is one of Europe's most important energy infrastructure developments in recent years.¹⁶

In the Middle East, one of the world's largest gas fields is situated at South Ghawar, Saudi Arabia. Exxon Mobil won the lead role in a \$15billion development.

Royal Dutch Shell are taking the lead role in the nearby smaller Shaybah Gas Project at a cost of \$5billion. A third project on the Red Sea has been awarded to Exxon. Phillips Petroleum, Occidental Petroleum, Marathon, TotalFinaElf, Conoco and BP Amoco are involved in all three gas projects, which together cover an area more than 440,000 square kilometres.¹⁷

"Gas was once the embarrassing accompaniment of a good oil-flow - best flared and forgotten. Not anymore. Pipelines and new technology, such as gas -to- liquids, are unlocking the value of gas as clean and plentiful energy source".¹⁶

¹⁵ Oil Gas JV 98, Number 23, pp63-68: "China launches massive gas pipeline campaign"

¹⁶ Petroleum Review April 2001 "Free market for European Gas in the pipeline", pp45-47.

¹⁷ The Times, 4th June 2001

. Liquified Natural Gas (LNG)

Whilst China has considerable reserves of natural gas, transportation from the reservoir areas in the west and north west to the demand areas on the Coast poses a problem which will take time to resolve. In the meantime, a short term solution is needed for the satisfaction of the demand for clean energy in the Coastal Provinces. One of the short term solutions is liquified natural gas. Imports of LNG are therefore expected to increase.

Growth of about 6% in Asian imports of LNG was recorded in the first three quarters of 2000. Changes in the patterns in the LNG trade have been established: a slower growth in Japan's imports and prospective new markets in India and China.¹⁸

. Liquified Petroleum Gas (LPG)

LPG is estimated to be used by more than 500million people worldwide. In 1999, LPG was reckoned to account for nearly 3% of total global energy consumption (and over 6% of global petroleum used for energy purposes). LPG tends to be in demand in areas of the world where the natural gas infrastructure is not yet sufficiently developed. Areas such as Asia, which are insufficiently served by natural gas pipelines, tend to have a greater demand for LPG.

This is the case in China. In the late 1990s the majority of LPG imports into China arrived via floating storage and ship -to -ship operations. Floating storage will play an important logistical role in China's LPG growth prior to construction of sufficiently large terminals.¹⁹

During the year 2000, LPG demand in China exceeded growth in available supplies from the Middle East. Such has been the demand that suppliers in the North Sea and Algeria have diverted LPG to the Far East. Far East LPG markets are estimated to be in a deficit position for LPG supplies during 2001 and 2002, with no improvement in the trade imbalance being seen until 2004.²⁰

Gas - to - Liquids (GTL)

The conversion of natural gas to liquid fuels has become established as an option for dealing with gas in remote areas. "Most telling is the strong public commitment to GTL by the new super-international BP Amoco. Announcing earlier this year the proposal to acquire Arco and to establish a major gas development programme in Alaska, John Browne, the company's Chief Executive Officer, claimed that BP Amoco has 'proprietary technology which we believe may allow us to convert some of Alaska's gas into liquids that can be transported by the existing oil pipeline.........We have plans to build a \$70million pilot plant in Alaska to test that technology.' BP Amoco is, naturally, studying commercial-sized projects for moving gas by pipeline and as LNG".²¹

The Fischer-Tropsch Gas-to-Liquids Technology is now said to have attained commercial status "providing an alternative means to monetise remote natural gas reserves by selling production into hungry markets. Whereas new supplies of LNG enter markets already in potential surplus, additional supplies of GTL diesel would represent only a small increment in supplies of automotive fuels."²²

¹⁸ Petroleum Review, April 2001: "LNG: Radical Changes Afoot", pp 30/31

¹⁹ 18th LNG/LPG International Conference in Dubai November/December 1998: "Demand for LPG in China", Heard, JC

²⁰ Oil Gas JV 99, No: 3, pp20-21: "Predicted shift in the world's LPG trade occurs", True WR

²¹ Petroleum Review January 2000, p34: "GTL begins to rival LNG" by Fred Thackeray

²² Petroleum Review April 2001: "Radical Changes A foot", supra

. Coalbed Methane (CBM)

Recovery of gas through coalbed methane development has three benefits: improving mine safety, protecting the environment and providing a new source of energy. China Coalbed Methane Clearinghouse has developed a financial analysis model to evaluate CBM projects at Chinese coalmines.

The Chinese Coalmining Industry and the Petroleum Industry, together with other organisations in China, have been exploiting CBM for a number of years and in 1996 the Chinese Government established the China United Coalbed Methane Corporation Limited. Approximately 150 CBM wells have been drilled in China. Productive CBM resources in China are put at approximately 14 trillion m³. These are distributed mainly in north and north-west China.²³

. Methane Hydrate

Will China be able to benefit from methane hydrate?

Estimates of the amount of methane hydrates worldwide differ considerably. For example, the US Geological Survey estimates that there are 700,000 trillion of of methane in gas hydrates: this potentially exceeds the combined international reserves of conventional oil, gas, coal and oil shale.

Methane hydrates are a mixture of gas and water. Usually a single methane molecule sits within a cage of 6 water molecules, forming a white, crystalline solid.

Most have formed offshore in deep ocean sediments or onshore in Arctic permafrost regions.

For several years, scientists have been working on ways to produce methane hydrate commercially. One of the simplest methods "involves drilling through hydrates that form a cap above a conventional natural gas deposit, and removing the gas. As the gas is depleted the hydrate cap de-pressurises and the methane is slowly released downwards into the conventional deposit"

There are considerable difficulties in the production of gas from solid hydrates. A number of nations have research programmes in operation: for example, the US Department of Energy recently earmarked some \$47million for research into methane hydrate²⁴.

²³ Alabama University, International Coalbed Methane Symposium, 7th July 1999. Authors Zhu C; Liu X; Wang S; Zhang, S; Li, W; Wang, Y

²⁴ Petroleum Review, September 2000, pp.30-31: "Production Potential of Methane Hydrate"

V Transportation

The Chinese Government intends to boost consumption of natural gas to 100billion m³/yr by 2010.

Onshore, the reserves of gas are in western China. To transport gas to the coastal markets in the east will require long distance pipelines.

China also has considerable offshore resources.

Transportation poses a serious and expensive problem in relation to both the onshore and offshore resources.

How expensive can be seen from the proposals made in the late 1990s for a Trans-Asia pipeline. Those proposals were made by the East Asia Consortium, comprising Exxon, CNPC and Mitsubishi. The 8,000 kilometre pipeline, to run west-east across China and then under water to Korea and Japan for the importation of oil and gas from Turkmenistan, Uzbekistan and Kazakhstan, was costed at between \$10billion and \$14billion.²⁵

But expensive or not, China needs gas: are there other solutions to the problem of transportation?

Apart from gas pipelines, there are other possibilities, some of which have been referred to earlier in this Paper.

- . LNG . But it is expensive, requiring temporary reduction of minus 161 degrees Celsius.
- GTL. As mentioned earlier, BP Amoco has stated that it has the necessary technology to convert Alaskan gas into liquids, thus enabling the gas to be transported on BP's existing oil pipeline.
- . LPG: using floating storage and ship-to-ship operations.
- Gas by wire. Gas burns at the well head to generate electricity. Electricity rather than gas is then transported. This offers a substantially simpler distribution infra-structure.

²⁵ Petroleum Review, November 1999, p24

VI Some Proposed Developments

Two developments proposed in mid 2001 give an idea of the direction in which China is moving in relation to gas.

Gas pipeline

China's leading oil company, PetroChina, plans to open talks with the world's top three oil conglomerates on the construction of an \$18billion gas pipeline.

PetroChina has picked British Petroleum, Exxon Mobil and Royal Dutch/Shell Group for negotiations on the construction of a pipeline which will run from north west China to Shanghai on the east coast.

China had said in February 2001 that 19 foreign energy companies had submitted bids to build the pipeline. BP, which holds a 2.2% stake in PetroChina, leads a consortium that includes three Japanese companies - Mitsubishi, Itochu and Nisshoeyawai - and the Malaysian state-owned oil company Petronas.

Exxon Mobil submitted a bid with Hong Kong's China Light and Power while Royal Dutch/Shell also put in a bid.

PetroChina said it will make a final decision on which of the three is to become its partner in the project. The project aims to pipe more than 12billion m³ gas annually from Xianjiang province's Tarim Basin to the booming coastal economy of the Shanghai Yangtze River Delta by 2005.

The pipeline is the centre-piece for China's drive to develop its economically backward but resourcerich western region.

PetroChina has said it would offer equity on natural gas fields in the Tarim Basin to foreign firms to attract them into pipeline construction, but has made it a pre-requisite that firms participate in the pipeline construction in order to tap the Tarim fields.²⁶

LNG Input Terminal

In was reported in May 2001 that BP had been selected to enter into exclusive negotiations to secure its position as the foreign partner in a joint venture to develop China's first LNG import terminal and associated pipeline.

The intention is that, following a jointly conducted feasibility study, BP and the Chinese authorities intend to form a joint venture company for the construction and initial operating stage of the new plant.

The project will be at Guangdong in southern China. It will consist of an LNG re-gassification terminal near the city of Shenzhen. It will have a capacity of 3million t/y, together with 300 km of associated pipeline. It is due on stream in 2006.

If the negotiations are successful, BP will take a 30% equity stake in the project, its partner being a coalition led by China National Offshore Oil Corporation (CNOOC).

The second phase of the project would be due on stream in 2008, adding a further 2million t/y of LNG re-gassification capacity, together with 180 km of pipeline.

"Gas currently meets just 2% of China's energy needs, but this number is projected to increase to between 7% and 8% by 2010".²⁷

²⁶ The China Daily, as reported in the Economic Times, India, 7th June 2001

²⁷ Petroleum Review, May 2001, p9

VII Conclusions

China is not alone in facing an energy crisis. Nor is it alone in relation to the problems of pollution. Those problems exist in other countries around the world.

One way of tackling both the problem of energy shortages and the problem of pollution may be an increased use of gas. If that is right, then again China is not alone in what it is doing: other countries around the globe appear to be following a similar course. Natural gas - in its different forms - may not only be China's fuel of the 21st Century.

It may prove to be the new, clean, alternative fuel worldwide.

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Table 1 Major Chinese Gas Fields

Field and location	Desciption	
Yacheng field, South China Sea	China's largest offshore gas field, with proven reserves of 85 BCM, it will deliver 2.9 BCM of gas annually via an 800-km pipeline to a 2,400 MW power plant in Hong Kong in 1999.	
Ping Hu field, East China Sea	By the end of 1998, it will supply a maximum of 0.5 BCM/ year to the Pudong area of Shanghai. Total estimated recoverable reserves are about 8 to 10 BCM.	
Xihu Trough East China Sea	Could have recoverable reserves of 70 BCM and total potential gas reserves of 400 BCM. Estimated production would be 5 to 8 BCM/ Year	
Ordos Basin, Shaanxi Province	Production capacity is 2BCM, although current production is less that half that. An 850-km gas pipeline runs from the Ordos Basin to Beijing where less than 0.3 BCM/year of gas are being consumed. Estimated reserves are about 20 to 30 BCM.	
Sichuan Basin, Sichuan Province	The largest basin in China, producing about 7BCM of gas annually, with potential expansion to 10 BCM. Increase in production is limited by the gas transmission network, which needs upgrading and expansion (CNPC and Enron have recently announced plans to build a pipeline to transport gas to Henan by 2000 and to Shanghai by 2002). Estimated reserves are 400 to 600 BCM.	
Tarim Basin	Only minor discoveries of gas have been made to date with no major production at present, although the area is geologically promising.	