China's Economic Reform and Industrial Sector Energy Requirement: A Forecast to 2015

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ABSTRACT

With its GDP growing at an average rate of 9.8% for the last seventeen years, China has the world's fastest growing economy. This rapid pace of growth and industrialization has caused economic strain because fuel production cannot keep pace with demand. If China allows this situation to continue, significant oil imports will be necessary. In 1993, the industrial sector contributed 56% to China's GDP and consumed 61% of the total final energy. The industrial sector will remain the largest energy consumer in China well into the next century.

According to China's Ninth Five-Year Plan (1996-2000), China will strengthen its ability to develop new products and will use technological advancement to promote industrial development. The Plan calls for special attention in four major areas: microelectronics technology, digital technology, software technology, and network technology. Given China's emphasis on developing light industries and on improving industrial sector energy efficiency, it is important to study the future energy demand of the industrial sector.

Two scenarios for future energy requirements are studied through the year 2015: a Business As Usual (BAU) scenario and an Energy Efficient (EE) scenario. The study evaluates China's current economic reform policies and energy efficiency policies. The results of this evaluation are used to assign appropriate growth rates to industrial GDP and the industrial energy intensity for both scenarios. Results from the two scenarios are compared and analyzed.

INTRODUCTION

Because of rapid economic growth and development, the type of energy demanded in China has gradually changed to electricity and oil products rather than coal. Power supply has become a serious problem in the coastal area. Almost all industries in these areas have their own backup power supply, primarily diesel power generators. Because the cost of supplying oil products and coal from domestic sources to these areas is very high, these areas have ended up importing energy from overseas. As a result, China has become a net oil importing country.

Total energy consumption in China doubled in 15 years, from 422 million ton oil equivalent (mtoe) in 1980 to 859 mtoe in 1994. Although the demand for oil products in coastal areas increased, in the country as a whole, coal made up 75% of the total primary energy consumption in China in 1994, oil made up 17.4 %, hydroelectric power 5.7%, and natural gas 1.9%.

Economic growth is the main driving force for increasing energy demand in China. However, economic growth cannot go on forever, and economic reforms come with a price. In China, economic reform and growth have widened the income gap between urban and rural populations and have encouraged corruption and crime. According to its Ninth Five-Year Plan, China intend to put emphasis on narrowing the income gap and controlling the growth of the economy. The question is, will that help ease the energy crisis in China.

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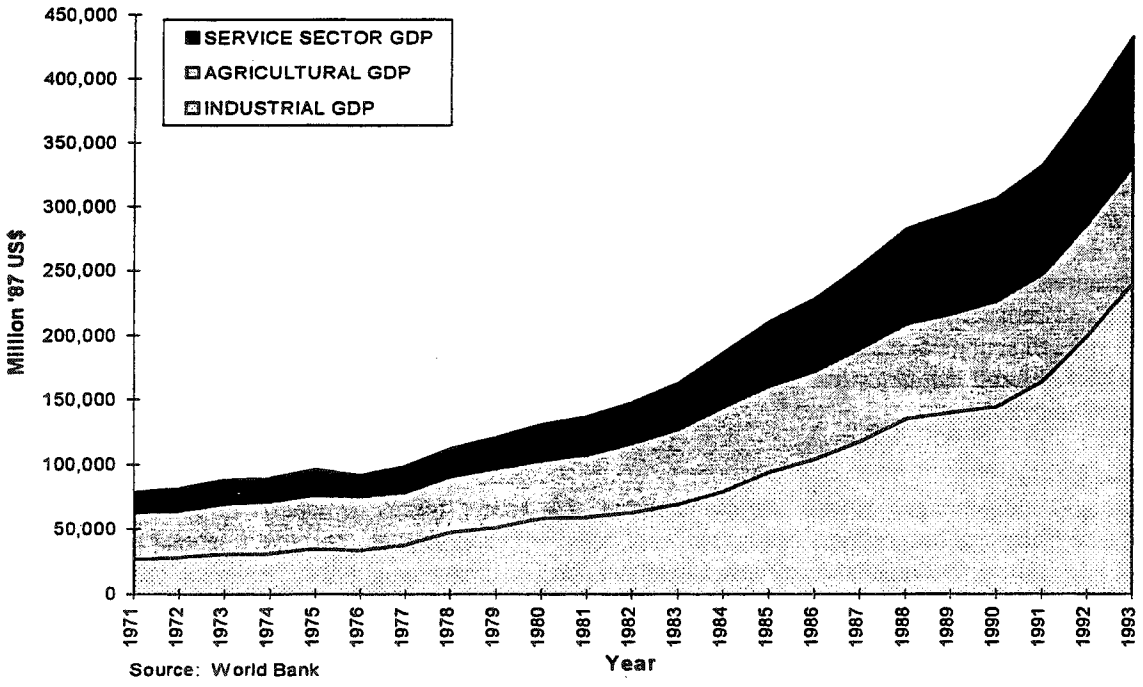
ECONOMIC REFORM IN CHINA

To study China, one must remember that over 70% of China's 1.2 billion population live in rural areas. Most of the rural populations are low-skill labor engaged primarily in farming-related work. This large informal agricultural sector helped China create employment in the non-state sector while the government was gradually reforming its inefficient state enterprises. However, this excess labor force also has become a hidden disaster in China. Millions of rural laborers flooded the cities when the income gap between the rural areas and the urban areas widened. These low-skill migrants have created serious social problems in the urban area of China.

China has the world's fastest growing economy. However, the fast economic growth has not affected all sectors equally. In 1993, agricultural output grew at less than 6%. In contrast, the industrial sector grew more than 20%, and the service sector grew 10% (Figure 1). A key feature of the Chinese economy is the very large share of industry in the overall economy; the service sector has also become increasingly important.

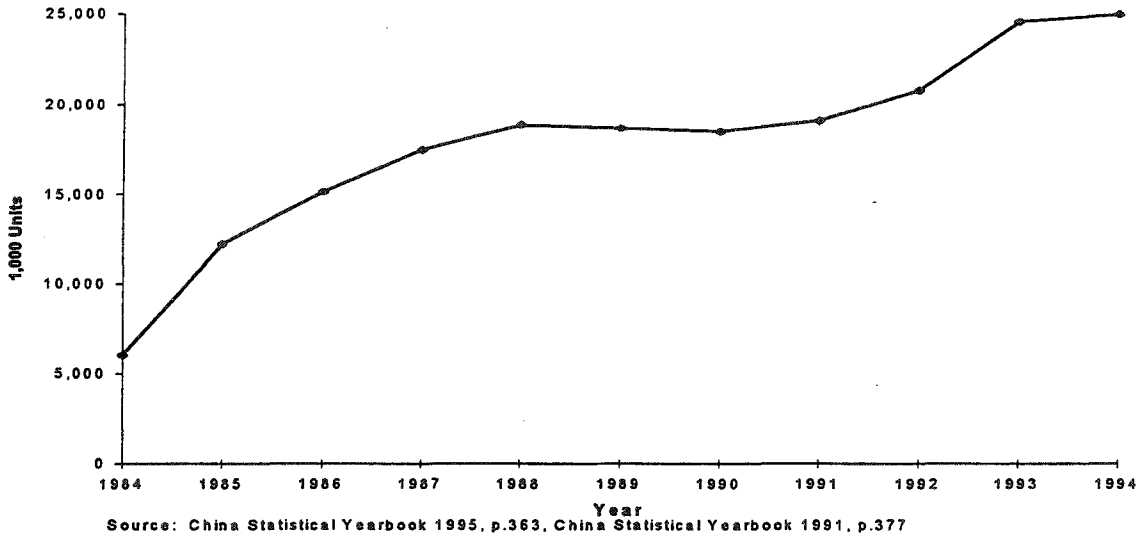
Figure 1 China Total GDP by Sector



After 1978, China dissolved the communes in favor of small-holder agriculture; a 25% real increase was set in relative agricultural prices.[1] These changes in incentive structure immediately raised farm productivity. The increased output improved the cash position of farmers who, in turn, could finance their own on-farm investments without borrowing from the state banking system.[2] In 1984, with pressure mounting to channel the savings into new industry, local authorities were granted permission to create township and village enterprises (TVEs).[1] Largely owned by local communities[b] and small-scale private traders, hundreds of thousands of the new TVEs flourished (Figure 2), producing light industrial and goods previously overlooked by state-run manufacturers.

[b] The TVEs were market-driven and outside the web of price and output controls that still circumscribed activities in the old state-dominated heavy-industry sector.

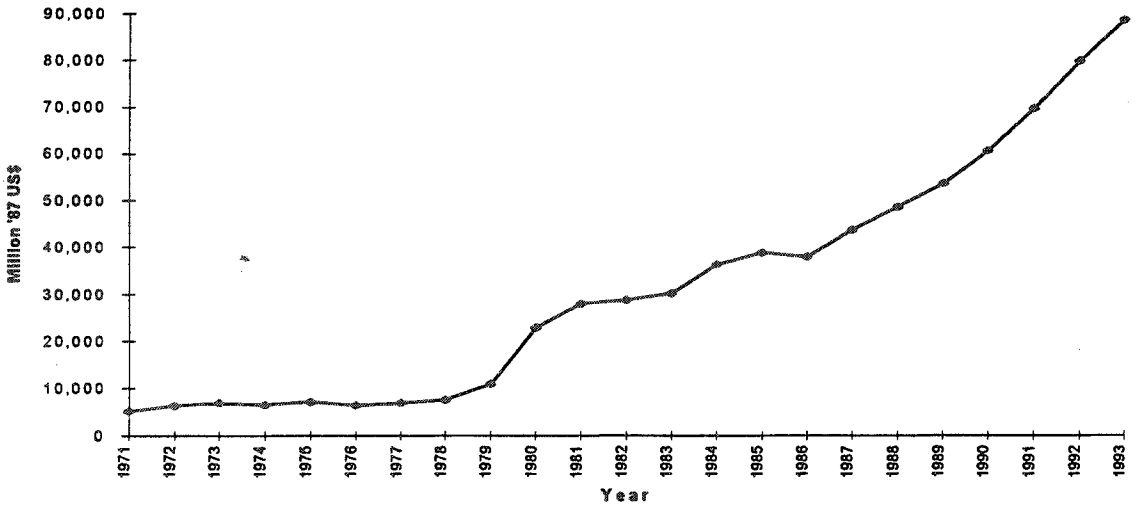
Figure 2 Total Number of Township and Village Enterprises



Source: China Statistical Yearbook 1995, p.363, China Statistical Yearbook 1991, p.377

China also adopted cautious approaches to foreign exchange and commercial policy reform. The central government initially allocated all foreign exchange at the official exchange rate, then gradually allowed an inter-enterprise swap market to develop at a variable, but modest, premium over the official rate. Through this policy, export enterprises were provided access to a realistic exchange rate, despite the general overvaluation of the local currency. Other policies designed to promote exports included the establishment of special economic zones and decentralization of foreign trade companies.(2) These policies helped China's export sector grow dramatically from '87US$5.2 billion in 1971 to '87US$88.8 billion in 1993 (Figure 3). This growth has underpinned the overall growth of China's economy.

Figure 3 China's Exports as a Capacity of Import



Notes: Exports as a capacity of import equals the current price value of exports deflated by the import price index
Source: World Bank

The benefits of fast economic growth, however, have not been equally distributed among all regions. The average household income in Beijing, Shanghai, Guangzhou, and Shenzhen, the four cities with the highest living standards in China, is 67% above the average national level for urban families, reflecting a huge income

disparity among cities. The income disparities are great even among the four cities, with an average family in Shenzhen earning nearly three times more than its counterpart in Beijing.[3]

Following the widened income gap are crime and corruption. Official figures show crime in Shenzhen has soared 40% per year over the past five years.[4] Official corruption, including rampant nepotism, was one of the main complaints that sparked the 1989 pro-democracy demonstrations in Tiananmen Square. Recently, graft levels have soared well past 1989 standards. For example, Beijing has admitted that US$2.2 billion disappeared from its municipal coffers in China's most serious corruption scandal since the Communist Party came to power in 1949.[5]

ENERGY DEMAND IN CHINA

China's total final energy consumption in 1993 was 559 mtoe. The industrial sector accounted for 61%, the transportation sector for 10 %, and the household/commercial sector for 20%. This composition by sector has been constant over the past ten years. China relies primarily on domestic energy resources and is one of the few countries in the world where coal is the principal energy source. In 1994, coal accounted for 75% of total primary energy consumption. Traditional energy is also important. In rural areas, biomass accounts for about 80% of energy consumption in the household sector. Energy consumption per capita is approximately one sixth of the OECD countries, while energy consumption per dollar of GDP is more than ten times as much.

Although coal is the main fuel used in the industrial sector, the consumption of electricity has increased sharply in recent years. During the 1980s, energy intensity declined in all industries except mining. This trend, which was more obvious in the consumption of fossil fuels, was due to the increase in industries that produced high-value-added products and energy conservation measures. Although the government has promoted energy conservation and has accelerated the supply of energy through the use of market mechanisms, energy use is still inefficient compared with that in industrialized countries. The main reasons for this inefficiency are 1) high dependency on coal,[c] 2) inefficient industry,[d] and 3) incomplete price liberalization up to now.[e] [6]

CONSERVATION POLICIES

The Chinese government wants to save 100 billion kWh by upgrading 70% of all industrial boilers and high-consumption electric motors. Computer-aided design will be used in 70% of the design work in medium-sized and large enterprises and leading research units, thus shortening the time needed to develop new products. Computerized control of production processes will also be promoted in 14,000 medium-sized and large enterprises, and computer-aided management will be introduced in 5,000 such enterprises to achieve better economic results. [7]

INDUSTRIAL SECTOR

Energy consumption in the industrial sector made up more than 61% of the total final commercial energy consumption in China in 1993. The total industrial energy consumption increased from around 200 mtoe in 1980 to about 350 mtoe in 1993. In 1993, direct use of coal made up almost 69% of all the final energy used in this sector, electricity 12.7%, and petroleum products 10.5% (Figure 4). The electricity share has been increasing quite rapidly, while the share attributable to direct use of coal has been gradually declining. The

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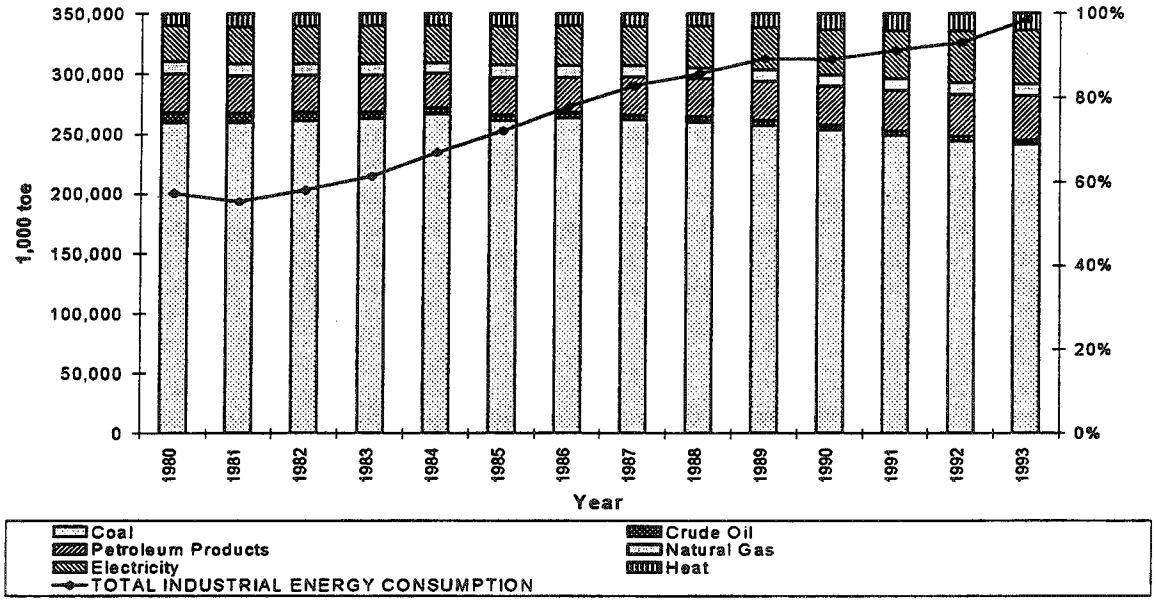
[c] The average thermal efficiency of the coal boilers used in the industrial sector is estimated at 50% to 60%, while the efficiency of the oil and gas boilers used in industrialized countries is 80% to 90%. The thermal efficiency of coal stoves used in the household sector is estimated at only 20% to 25%. That of modern gas stoves is in the range of 55% to 60%.

[d] The industrial sector has been growing rapidly, and its share of final energy consumption in 1990 was 64%. But the sector has a high energy intensity because most industries are still using old equipment in smaller plants that preclude economies of scale. The amount of energy required to produce a unit of steel, cement, ammonia, or paper is considerably more than what is required in industrialized countries (sometimes twice as much).

[e] Although the government decided to liberalize most energy prices at consumer levels, mixed price formulas continue to exist during the current transitional period. Up to the early 1990s, energy prices were so low that enterprises had little incentive to try to conserve energy. Low prices also constrained the development of new energy supplies.

Figure 4 Total Industrial Energy Consumption by Fuel Type



Source: IEA

industrial energy intensity in 1993 was 1.44 1,000toe/Million '87US$, which is much higher than U.S. industrial intensities of 0.52 1,000 toe/Million '87US$ in 1970.[f] The energy intensity of Chinese industry has been declining at an average rate of about 6% every year since 1980. At the same time, however, the industrial GDP has been increasing at an average rate of about 10% every year (refer to Figure 7).

According to Levine et al.,[8] 80% of the reduction in energy intensity between 1980 and 1985 is due to industry; of this 80%, 91% is due to efficiency improvement and 9% to structural change. Almost all energy savings in China have occurred through efficiency gains in industry; specifically, actions in chemical, metallurgy, cement, and paper and pulp have been the major sources of reduced energy intensities in the early 1980s.

As indicated in the Ninth Five-Year Plan (adopted at the Eighth National People's Congress in March 1996 in Beijing), China intends to continue efficiency improvements by readjusting and optimizing the industrial structure, revitalizing pillar industries, and expediting the development of the tertiary sector.[7] Electronic information technology will be promoted throughout the country to allow the people to become better informed. The overall strength of the electronic industry will be further enhanced, making it one of China's pillar industries. Special attention will be paid to four major areas: microelectronics technology, digital technology, software technology, and network technology.

The iron and steel, cement, fertilizer, and pulp and paper industries are analyzed briefly as typical examples of energy-intensive Chinese industry. These sectors are the largest industrial energy consumers.

Iron and Steel Industry

The steel industry is the second largest energy user in China's industrial sector. The overall energy intensity of China's steel industry decreased from 1.43 toe/ton of crude steel to 1.13 toe/ton of crude steel between 1980 and 1990. Adjusted industry-wide, energy intensity in China was 35% higher than in the United States, and the more advanced steel plants had energy-intensity figures that were 20% higher than in the United States.[6]

[f] A market exchange rate was used to convert Chinese Yuan to US$; if a purchasing power parity exchange rate were used, the energy intensity for China could be lower.

The iron and steel industry in China has been targeted for energy conservation since the early 1980s. The overall energy intensity of crude steel decreased more than 20% from 1980 to 1990. Overall energy intensity has decreased because of the decreasing share of open hearth furnaces (OHFs) and the increasing ratio of continuous casting. However, some energy efficiency indicators have actually deteriorated in recent years. For example, the industry average of the coke equivalent rate (fuel used to produce pig iron) rose from 605 kg/ton of pig iron to 611 kg/ton of pig iron between 1985 and 1990.[6]

China's crude steel production is expected to reach 172 million tons by 2005 and its potential imports of iron ore could reach 90 million tons, compared with 37 million tons in 1993. China's iron ore imports are expected to rise to 56 million tons in 2001; its steel production, after rising by 46 million tons to an estimated 93 million tons between 1985 and 1995, is expected to rise further to 95 million tons in 1996 and to 114 million tons in 2001.[9]

Cement Industry

China produces over one quarter of the world's cement, making it the world's largest producer. Its cement output was 210 million tons in 1990 and grew to more than 421 million tons in 1994. China's cement industry relies on vertical-kiln equipped (VK) small plants for the bulk of its production. In 1990, VK plants turned out 70% of the total cement production. Meanwhile, modern precalciner kiln-equipped plants produced less than 5%. The rest was produced by wet process plants, which accounted for 11% of total production, and other types of dry or semi-dry process plants.[g] The cement industry consumed about 29 mtoe of energy in 1990.[6]

Energy efficiency in the industry is very low. Industry-wide fuel intensity for clinker making is about 126 kg of oil equivalent (kgoe)/ton of clinker, whereas that of Japan's industry is 71 kgoe/ton of clinker. Electricity intensity was about 110 kWh/ton of cement in 1990, which compared favorably with that of industrialized countries. Consumption of electricity is low because of the large number of small labor-intensive plants. Modernizing China's cement industry has been a unique endeavor because of the presence of so many inefficient VKs. Conservation measures adopted by the industry in the 1980s included comprehensive retrofit of VKs, conversion of wet process kilns to semi-dry or dry process kilns, and the introduction of large-scale precalciner kilns. Inefficient small plants were closed and wet and dry process kilns were also retrofitted.[6]

Fertilizer Industry

China introduced a process for producing ammonia and ammonium bicarbonate from coal in the early 1960s. Although ammonium bicarbonate is a low grade and inefficient nitrogen fertilizer, it satisfied China's needs at that time. Although large plants in China have been modernized during the past several years, their energy consumption to produce a unit of ammonia is still estimated at 20% to 25% higher than that of plants of recent design. The efficiency in medium-sized and small plants is much lower than that of large plants. Energy consumption per unit of output at small plants was 76% higher than that of the large plants and 23% higher than that of the medium-size plants. The low efficiency is attributed not only to plant size, but also to the feedstock used for ammonia synthesis. Coal is still used as the main feedstock in China, whereas 98% of the feedstock in the United States is natural gas.[h] However, many of these existing plants throughout the country remain strategically important because China's transportation infrastructure is not sufficiently developed to transport fertilizer effectively.[6]

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[g] The technologies used in cement production differ greatly, ranging from wet and dry process technologies of 1940s vintage to state-of-the-art precalciner kilns and from the most primitive VKs to some very efficient mechanized vertical kilns. The fuel intensity of clinker making has been declining as the industry has converted from manual VKs to mechanized VKs, adopted other efficiency measures, and introduced modern precalciner technology. However, because of automation and increased fan power, such upgrading has also increased industry's electricity intensity.

[h] This high dependency on coal decreases the industry's overall energy efficiency. Coal-based ammonia production consumes about 35% more energy than gas-based with today's technologies.

China unveiled a 15-year blueprint for the country's chemical industry in March 1996. Calling for the expansion of chemical plants and projects and the boosting of foreign investment in the sector, the focal point of the plan will be chemicals for agriculture use, including fertilizers, pesticides, plastic film, and feed additives. The proposed chemical fertilizer project aims to increase national annual output of pure chemical fertilizers to as much as 29 million tons, up from the current 24.5 million tons.[i] The pesticide project will produce highly efficient, low-toxic pesticides that will be safe for the environment.[10]

Pulp and Paper Industry

The pulp and paper industry is the second most energy-intensive industry in the world, ranking only behind the iron and steel industry. China produced 21.4 million tons of machine-made paper and paperboard in 1994 (8% of the world total), making it the fourth largest producer in the world. Most of the technology used in China's pulp and paper industry is like that used during the 1940s and 1950s in industrialized countries. Only a few enterprises have reached the technology level used by industrialized countries in the 1960s and 1970s. The energy intensity of China's paper industry was estimated at 7.1 million kcal/ton of paper products as of 1985.[j] The low energy efficiency of the industry has been attributed to the small scale of most enterprises, the use of old technology and equipment, the inferior quality of raw materials, and the lack of energy recovery and reuse.[6]

METHODOLOGY

In this study, future energy requirements will be estimated by forecasting and then multiplying activity and energy intensity to 2015. Two scenarios for future energy requirements will be studied through the year 2015: a Business As Usual (BAU) scenario and an Energy Efficient (EE) scenario. The BAU scenario forecasts total energy requirements given the current trend in energy consumption and current policies affecting energy use. Energy consumption and the activity measure (industrial GDP) will be projected based on past trends. The EE scenario will project future energy requirements assuming the industrial sector reduces its energy intensity level by adopting more energy-efficient technologies.[11]

DATA

Energy data were compared from four different sources: the China State Statistical Bureau, the Lawrence Berkeley National Laboratory (LBL), the Asian Development Bank (ADB), and the International Energy Agency (IEA). While it would be ideal to use data from the original country, the sectoral classification of fuel consumption in China differs greatly from practice in market economies. Sectoral consumption is defined according to the economic branches to which the user of the fuel belongs, rather than according to the purpose or use of the fuel, as is common in the western world. For example, gasoline consumption in the vehicle fleet of an enterprise attached to the economic branch of iron and steel is classified as industrial consumption of gasoline in the iron and steel industry.[12,13,14,15] Therefore, compiling Chinese data into the western scheme without making major assumptions is nearly impossible, although IEA, ADB, and LBL all have tried to do that.[16,17]

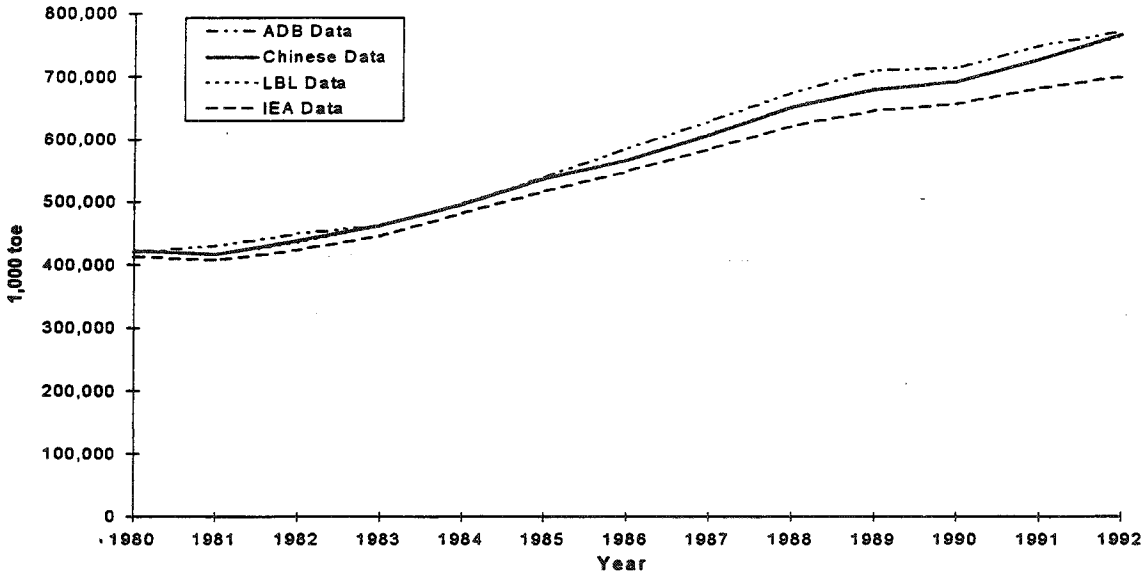
China reported energy data in 10,000 ton standard coal equivalent (tce), and LBL reported Chinese energy data in Mtce. Assuming one kg of standard coal equivalent equals seven kcal,[18] we converted the Chinese primary and final energy consumption data from 10,000 tce and Mtce to 1,000 toe and compared that with the data from ADB and IEA (Figures 5 and 6).

As the figures show, the primary energy consumption data from different sources are quite similar (Figure 5), while final energy consumption data differ significantly (Figure 6). The differences can be explained by what is included in the transformation sector. Clearly, the LBL scheme for handling this sector is similar to the Chinese scheme, and ADB uses a scheme similar to that of the IEA. Although they all correctly capture the

[i] To achieve this, several old enterprises will be upgraded, while new plants will be built in Hainan and Xinjiang to make use of locally available rich deposits of natural gas.

[j] Almost 60% more than the 4.479 million kcal/ton-of-paper products in Japan in 1991.

Figure 5 China Primary Energy Consumption: Comparison of Data from Four Sources

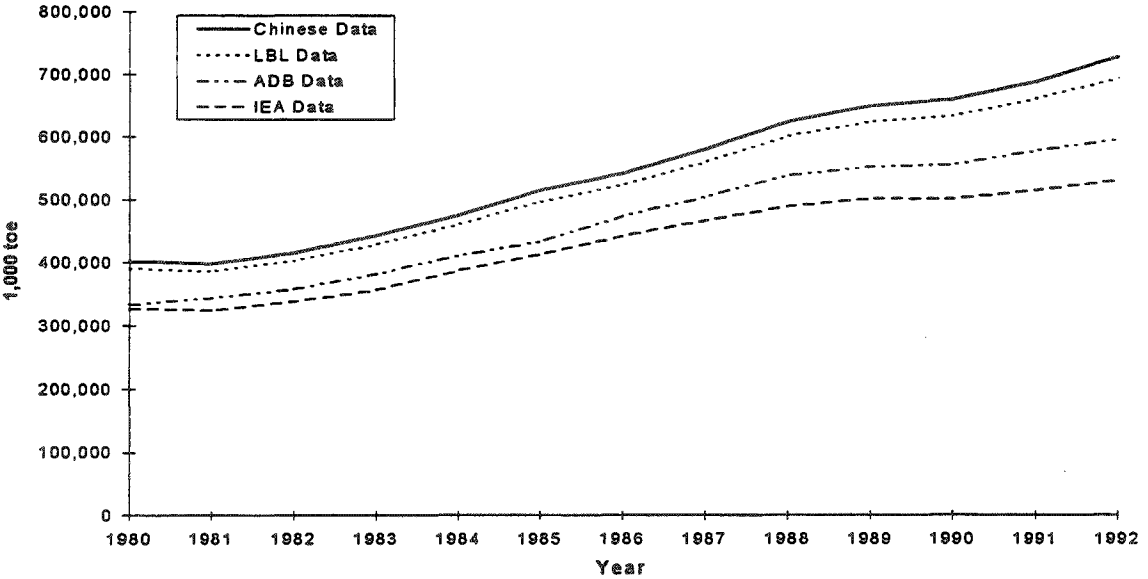


Source: China Energy Statistical Yearbook 1991, p.205, China Statistical Yearbook 1994, p.194, China Energy Databook 1996 (LBL), p. IV-11, ADB, IEA

growth trend of Chinese energy consumption, the IEA scheme is clearly separating more of the transformation losses from end-use sectors (i.e., separates oil refinery from the industrial sector, etc.) and is closer to most of the schemes used by the western world.[16,17] Therefore, the IEA data were used in this study.

Further, all energy data used for this analysis are 1995 IEA data, unless otherwise specified. Most of the other economic data, including data for GDP, sector value-added, and population growth, are compiled from the World Bank data[19] or the China Statistical Yearbook.

Figure 6 China Final Energy Consumption: Comparison of Data from Four Sources



Source: China Energy Statistical Yearbook 1991, p.205, China Statistical Yearbook 1994, p.194, China Energy Databook 1996 (LBL), p. IV-27, ADB, IEA

BUSINESS AS USUAL SCENARIO

The industrial energy intensity defined here is the industrial final energy consumption divided by the industrial GDP. The energy intensity is assumed to continue decreasing. For the next five years (until 2000), the energy intensity is assumed to decrease at the current rate of 6% per year. From 2000 to 2005, it is assumed to decrease 3% per year, 2% per year from 2006 to 2010, and 1% per year from 2011 to 2015 (Table 1). In other words, the rate at which the energy intensity is dropping is assumed to be decreasing. Therefore, from 1994 to 2015, the energy intensity would be decreasing on an average rate of 3% per year.[k]

Table 1 Annual Growth Rate Projected for Industrial Sector Energy Intensity

	1994 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
BAU	-6%	-3%	-2%	-1%
EE	-6%	-3.5%	-2.5%	-1.5%

Energy intensity in expected to keep decreasing for three major reasons:

- Improvements in technical efficiency and shifts toward more expensive products within sectors will occur. China will renovate traditional industries by upgrading 70% of all industrial boilers and high-consumption electric motors. In medium-sized and large enterprises and leading research units, computer-aided design will be used in 70% of the design work, thus shortening the time needed to develop new products. Computerized control of production processes will also be promoted in 14,000 medium-sized and large enterprises, and computer-aided management will be introduced in 5,000 such enterprises to achieve better economic results.(7)

- Structural changes and shifts in the relative output shares among the major sectors, which China has already announced in its Ninth Five-Year Plan, will shift its heavy-light industry ratio from 57:43 to 50:50. Info-technology and the electronic industry will become one of China's pillar industries, producing higher value products that require less energy to produce.

- China has a huge, ill-managed labor pool; there is still much potential for production line management to be improved. Encouraging investment in central and western regions will allow these areas to compete with the coastal cities, thus stimulating productivity.

We assume the intensity will decline to 787 toe/Million '87US$ by the year 2015, which is still higher than the U.S. industrial energy intensity in 1973, which was 500 toe/Million '87US$.

We assume the industrial GDP will grow at an annual rate of 11% until 2000, and 9% per year from 2001 to 2005, 8% from 2006 to 2010, and 7% from 2011 to 2015 (Figure 7). In other words, the rate at which the industrial GDP is growing is assumed to be decreasing. No economy can grow indefinitely at such a high rate, especially not China, which has made slowing down the economy its main goal. Industrial GDP is assumed to grow faster than the total GDP, however, because industrial GDP makes up over 55% of the total GDP, and China is attempting to develop high-value-added light industries. Therefore, the industrial sector will remain the leading sector in the future economy in China.

Although energy intensity is dropping, the high rate of industrial GDP growth outstrips the benefit of lowering energy intensity. The net result is that the industrial final energy requirement will increase and reach 1.24 btoe in 2015 (Figure 8).

[k] This rate is similar to the experience of South Korea. The industrial energy intensity in South Korea dropped at an average rate of 3.8% per year for at least 15 years before it leveled out in 1988.

Figure 7 China Industrial GDP and Industrial Energy Intensity Projection

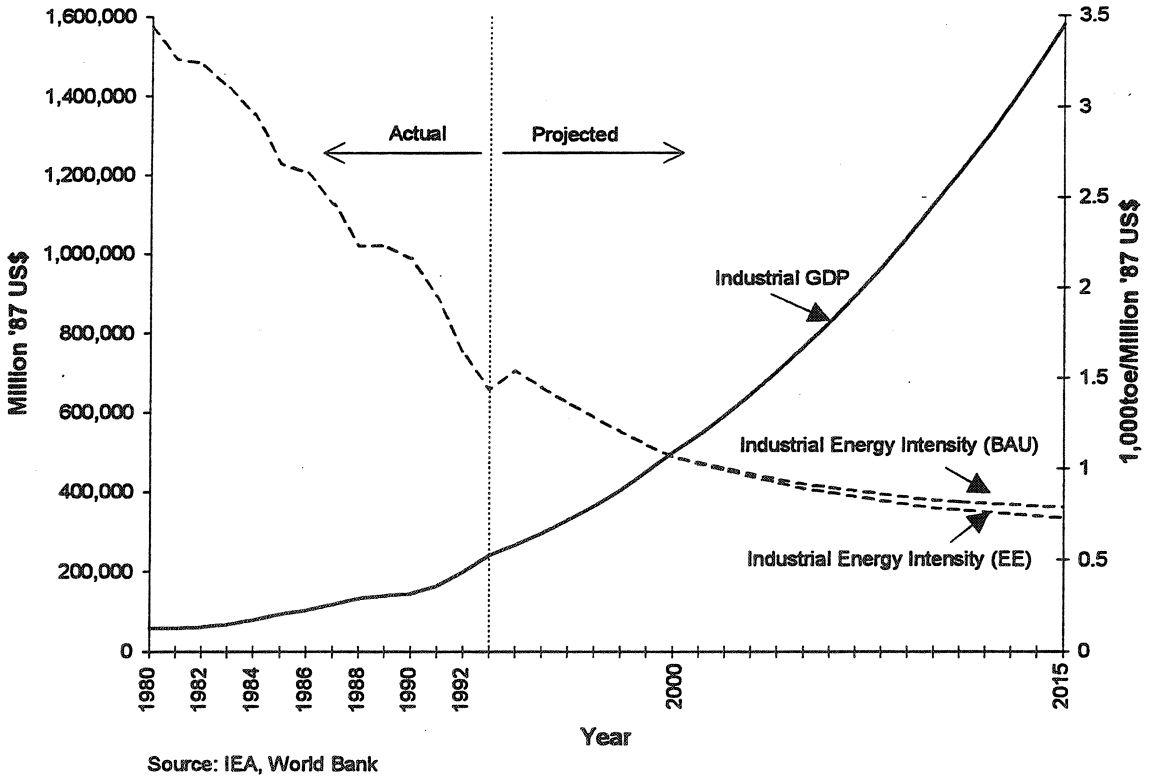
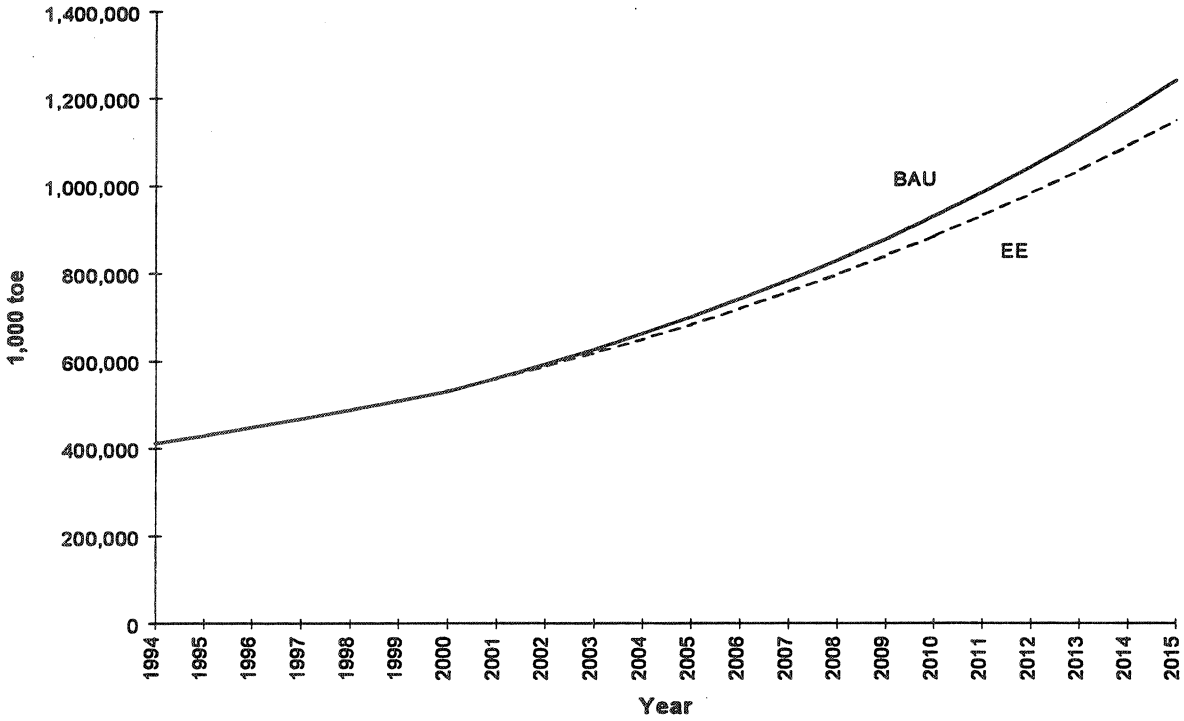


Figure 8 Projected China Industrial Energy Requirement



ENERGY EFFICIENT SCENARIO

Under the EE scenario, energy intensity is not expected to drop much more than under the BAU scenario because 6% per year decrease is already a very high percentage for a developing country.[20] Therefore, under the EE scenario, we assume that until 2000, energy intensity will decrease at the current rate of 6% per year, the same as the BAU scenario. From 2000 to 2005, it is assumed to drop 3.5% per year; 2.5% per year from 2006 to 2010; and 1.5% per year from 2011 to 2015, which is 0.5% faster than the BAU scenario (Table 1). Industrial GDP is assumed to grow at the same rate as in the BAU scenario (Figure 7).

Under the EE scenario, the industrial final energy requirement is estimated to reach 1.15 btoe in 2015, 95 mtoe less than the BAU scenario (Figure 8).

CONCLUSION

China's industrial energy demand will increase threefold to 1.24 btoe by the year 2015. Although China is actively promoting energy efficiency measures and developing high-value-added light industries, the rapid growth in the economy is expected to outstrip the benefit of the reductions in energy intensity. The net result is an increase in energy demand.

Although the Chinese government wants to slow the growth of the economy, China's GDP is still expected to continue to grow above the world average well into the next century. The industrial GDP is assumed to grow faster then the total GDP. The industrial sector will remain the single most important contributing sector to the overall GDP in China, and this sector is expected to continue to grow faster then the whole economy. Even under the EE scenario, the industrial energy demand will still increase to 1.15 btoe by 2015.

Having said the above, even though China's industrial energy intensity will decline to 787 toe/Million '87US$ by the year 2015, it will still be higher than U.S. industrial energy intensity was in 1973 (500 toe/Million '87US$). In order to achieve zero growth in industrial energy consumption, China would have to keep reducing its industrial energy intensity at the current rate of 6% per year and, at the same time, to keep the industrial GDP growth rate under 6% for the next 20 years. China should keep its momentum to improve energy efficient standard and to maintain its control on economic growth. To achieve zero growth in industrial energy consumption in China may not be impossible after all.

REFERENCES

1. The World Resources Institute. 1994. *World Resources 1994-95: People and The Environment.* Oxford University Press, New York, New York.

2. Rana, P.B,, and N. Hamid, eds. 1995. *From Centrally Planned To Market Economies: The Asian Approach. Volume 1.* Published for the Asian Development Bank, Oxford University Press, New York, New York.

3. *Hong Kong Standard* . May 20, 1996.

4. *Hong Kong Standard.* April 10, 1996.

5. *Hong Kong Standard.* April 16, 1996.

6. Ishiguro, M., and T. Akiyama. 1995. *Energy Demand in Five Major Asian Developing Countries.* Discussion Paper Number 277, The World Bank, April 1995, Washington, D.C.

7. Hong Kong Trade Development Council. 1995. *China's Proposal For The Ninth Five-Year Plan (1996-2000) and Long-Term Targets For The Year 2010 and Its Impact On Hong Kong.* Hong Kong Trade Development Council, Hong Kong.

8. Levine, M.D., F. Liu, and J. Sinton. 1992. "China's Energy System: Historical Evolution, Current Issues, and Prospects." *Energy Environ.* 1992. 17:405-35.

9. *Hong Kong Standard.* March 14, 1996.

10. *Hong Kong Standard.* March 29, 1996.

11. Roop, J.M., K.A. Freund, P.Godoy-Kain, A.Y. Gu, A.K. Johnson, O.H. Paananen, and M.G. Woodruff. *Regional Growth and Energy Supply: Is There an Energy Security Issue?* PNNL-11436, Pacific Northwest National Laboratory, Richland, Washington.

12. China State Statistical Bureau. 1991. *China Energy Statistical Yearbook 1991.* China Statistical Publishing House, Beijing, China.

13. China State Statistical Bureau. 1994. *China Statistical Yearbook 1994.* China Statistical Publishing House, Beijing, China.

14. China State Statistical Bureau. 1995. *China Statistical Yearbook 1995.* China Statistical Publishing House, Beijing, China.

15. Lawrence Berkeley National Laboratory. 1996. *China Energy Databook.* Lawrence Berkeley National Laboratory. Report LBL-32822 Rev. 3.

16. Asian Development Bank. 1994. *Energy Indicators of Developing Member Countries of ADB.* Asian Development Bank, December 1994, Manila, Philippines

17. International Energy Agency. 1995. *Energy Statistics and Balance.* Diskette Service, May 1995, The Organisation for Economic Co-operation and Development, Paris.

18. International Energy Agency. 1995. *Energy Statistics and Balance of Non-OECD Countries: 1992-1993.* The Organisation for Economic Co-operation and Development (OECD), Paris.

19. World Bank. 1995. *World Data 1995: World Bank Indicators on CD-ROM.* The World Bank, September 1995, Washington, D.C.

20. International Energy Agency (IEA). 1995. *World Energy Outlook, 1995 Edition.* The Organisation for Economic Co-operation and Development, Paris.