

## STATUS OF CHINA'S ECONOMY, ENERGY CONSUMPTION AND CO<sub>2</sub> EMISSION

GIANCARLO SANTOPRETE (\*), JUAN WANG (\*\*)

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### Abstract

Since 1980s the policies of government of the People's Republic of China have been particular effective in ensuring economic development, enhance of well-being of population, even if some objectives and needs have not been fulfilled yet (eg. equity among different regions, lower energy intensity, etc.). As the authors point out, the positive results can be shown by some indicators (for example, the decrease of infant mortality), as well as some achievements on top of the world (for example, the construction of the longest bridge of 36 km in the world in Yangtze River Delta area). As we know, the positive results above would be impossible without a firm government policy in favor of a substantial increase in total and per capita energy availability, which has encouraged an acceleration of industrialization, progress of urbanization.

From 2001 to 2005, total primary energy consumption in China has a notable increase, accounting for 24% of the world total increase. At the same time primary energy consumption per capita increased 46.7% since 2001, which will have huge influence on the world energy market. However, high energy intensity has become one of important bottlenecks restricting development of China at present, and with the coal-based energy structure now and in a long term, China has become the world's second-largest source of carbon dioxide emission behind the United States. Therefore the Chinese government is facing a further challenge: to balance the further need for economic and social development and the need for reduction of pollutants emission and pressure on resources; to mitigate the gap between urban and rural areas. At present, global warming caused by CO<sub>2</sub> and other

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(\*) University of Pisa, Faculty of economy, Via C. Ridolfi, 10, 56124 Pisa, Italy.  
E-mail: g.santoprete@ec.unipi.it

(\*\*) Tongji University (China), College of environmental science and engineering, Siping Road 1239#, Shanghai, China. E-mail: wangjuan@mail.tongji.edu.cn

greenhouse gases has become the prime global environmental problem, as one of contracting parties of "Kyoto Protocol", China is actively taking measures to reduce CO<sub>2</sub> emission.

### **Riassunto**

Nell'ultimo quarto di secolo ed in particolare nel decennio appena trascorso la politica del Governo della Repubblica Popolare della Cina è stata particolarmente incisiva nel garantire lo sviluppo economico, la crescita dei consumi e il benessere materiale della popolazione, anche se taluni obiettivi non sono stati centrati e diverse esigenze debbono ancora essere soddisfatte. I positivi risultati sono avvalorati da diversi e significativi indici (ad esempio la riduzione del tasso di mortalità infantile ecc.) come anche dal raggiungimento di taluni primati (ad esempio la costruzione del più lungo ponte del mondo ecc.). Ebbene, come si può ben comprendere, i positivi risultati non sarebbero stati possibili senza una decisa politica governativa a favore di un consistente incremento delle disponibilità energetiche totali e pro capite. Queste hanno favorito un'accelerazione della industrializzazione, la conversione della popolazione agricola ed un incremento della urbanizzazione.

Con riferimento agli anni 2001-2005 viene dato conto del fatto che l'incremento del consumo energetico primario ha rappresentato il 24 % dell'incremento totale registrato a livello mondiale e che il consumo pro capite di energia primaria ha avuto un aumento del 46,7 % rispetto al 2001, con conseguenze non indifferenti sul mercato energetico mondiale. D'altronde, se da un lato questo ricorso a quantità crescenti di energia è stato alla base del rapido sviluppo economico, tecnologico e sociale accennato, dall'altro è stato anche responsabile di un depauperamento delle risorse interne cinesi e di un crescente tasso di inquinamento ambientale. Alla Cina spetta il primato dei consumi di carbone fossile e questo contribuisce a porre il Paese al secondo posto, dopo gli Stati Uniti, per le emissioni di CO<sub>2</sub>. Al Governo del Paese si prospetta pertanto una ulteriore grande sfida: quella di contemperare le esigenze future per ulteriori sviluppi economici e sociali con quelli della riduzione delle emissioni inquinanti e della pressione sulle risorse, nonché di attenuare le disuguaglianze tra le diverse regioni e tra coloro che vivono nelle campagne e quelli che abitano nelle città ecc. Ciò è invocato dalla popolazione e richiesto dalla soddisfazione degli impegni presi dal governo di Pechino a livello internazionale. Comunque un problema che sembra prioritario e che è ben chiaro al Governo è la tutela dell'ambiente. Ciò è mostrato ad esempio dalla accettazione da parte cinese del protocollo Kyoto, che come noto è volto a ridurre le emissioni di CO<sub>2</sub>.

**Keywords:** China; GDP growth; energy consumption; energy intensity; CO<sub>2</sub> emission

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## **Introduction**

After nearly 30 years of reform, China's economy has made great achievements. The regional economic policies are also being adjusted in the process of evolution. According to the different regional policy focus, China's economic development is divided into three stages:

### *A) Focusing on the economic efficiency (1978 to 1990).*

In this stage, in order to promote the rapid growth of domestic economy, Chinese Government proposed the regional development policies aiming to enhance the overall strength of national economy and pursue the overall economic growth efficiency. In the "The Sixth Five-Year Plan of national economic and social development" (1) Chinese government pointed out: "Actively use the existing foundation of coastal areas and make full use of their advantage to promote the mainland's economic development." The Eastern region with stronger growth advantage should be given priority to be developed to promote the common development of other regions.

### *B) Considering the efficiency and equity at the same time (1990~1999).*

When development strategies with the core of economic growth achieved certain efforts, with the expand of the economic gap among the Eastern, Central, and Western regions, the regional development policies aiming at pursuing the overall economic efficiency have been challenged. Starting with the whole benefit of improving national economy, Chinese government began to pursue the harmonious development of regional economy. Regional development policy changed from a pure focus on economic growth to pursuit of efficiency and regional equity.

### *C) Focusing on the regional equity (since 1999).*

After 20 years of economic development, China's overall economic strength has been noticeably enhanced, while the economic gap among the East, Central and Western regions has not been narrowed, and is still gradually widening. Solving the widening gap becomes the standpoint of regional policy, the focus of which is the regional equity (1). The great achievements of the Chinese socio-economic development since

China's reform are recognized by the whole world. But the difficulties and problems appearing at the same time are also evident, such as resources and environmental pressure, the inequity of development, including the imbalance between urban and rural areas and the imbalance between different regions. In order to solve these issues, the Chinese government proposes the social and economic policies of building a sustainable and harmonious society based on "scientific development concept" (2).

First, promote technological progress, change the mode of growth, optimize the industrial structure to reduce the pressure on resources and environment. The Chinese government has taken environmental protection and resources saving as a basic national policy, to use less consumption of resources to achieve sustainable economic growth.

Second, implement coordinated development strategies to ease the imbalance of development. The regional gap is caused by the imbalance between urban and rural areas and difference of urbanization level in regions to a considerable extent. The Chinese government is making efforts in two ways: first is promoting transfer of agricultural labor to non-agriculture industry, the second is the construction and reform of rural area (2).

Under the guide of the Chinese government, as the world's largest and fastest-growing developing countries, China has made great achievements in economic and social development and is playing an increasingly important role in the world economic stage since the end of the 1980s. From 1980 to 2005, China's population increased from 987 million to 1,311 million, in this period, the average annual growth rate of GDP was 10.7%, the average annual growth rate of GDP per capita was 9.5%, far exceeding those of developed countries and the world.

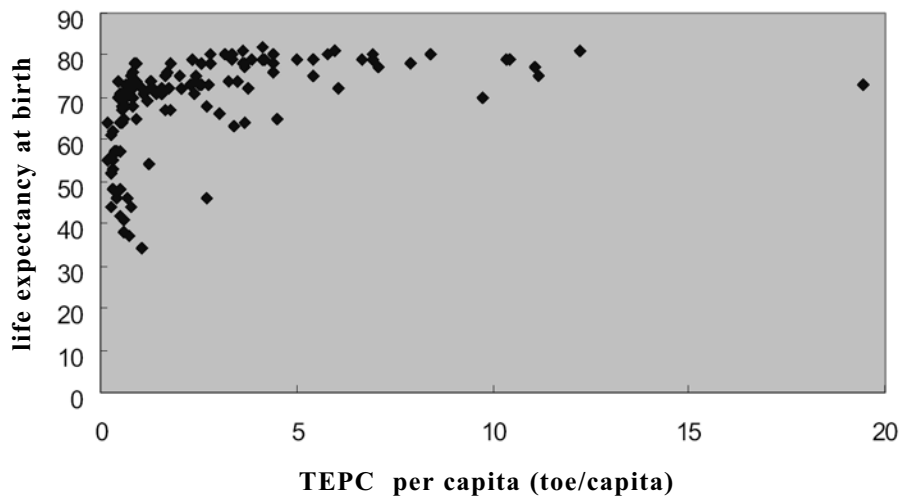
### **Energyian indispensable factor for Chinese socio-economic development**

Population changes, economy growth and social progress all stimulate production and consumption of goods. In this process, energy is one of key roles. Without energy, it is impossible to get our food, to operate a manufacture factory, to transfer gross matter to product we need in daily life. Improving energy utilization not only contributes the economic growth but also is the need for improvement of quality of life. The satisfaction of all the human life demand depends upon energy to reproduce all the needed products. With the increase of national income level, people must

establish many industries consuming more energy to guarantee a good quality of life, which means there is close correlation between the quality of human life and energy (3).

Then here, average "life expectancy" and "infant mortality rate" are taken as indexes to demonstrate this correlation.

On the basis of data provided by the United Nations and International Energy Agency (4 - 6), Figure 1 and Figure 2 show the trends of "life expectancy at birth" and "infant mortality rate" corresponding to different primary energy consumption per capita of 126 countries in 2005.



*Fig. 1* - Correlation between total annual primary energy consumption (TPEC) per capita and life expectancy at birth

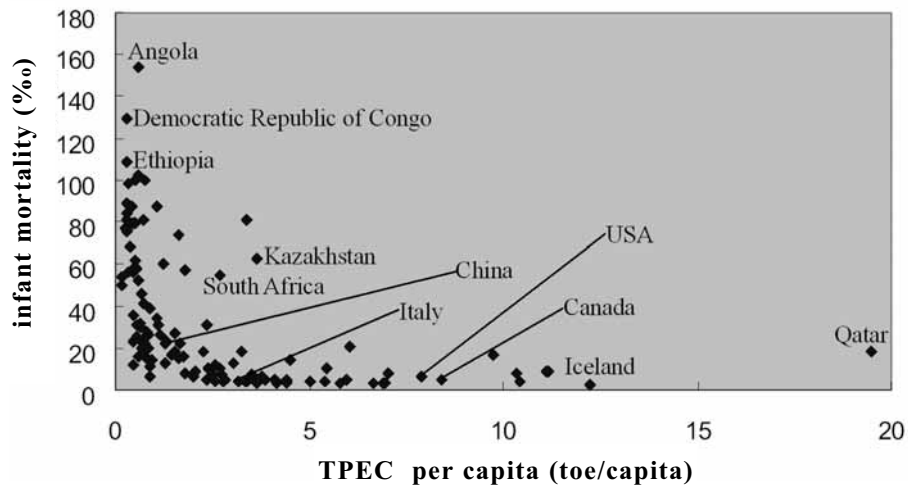


Fig. 2 - Correlation between total annual primary energy consumption (TPEC) per capita and infant mortality

A further way of confirming the link between the welfare of a nation and energy is the relation between GDP per capita and total primary energy consumption (TPEC) per capita (Figure 3).

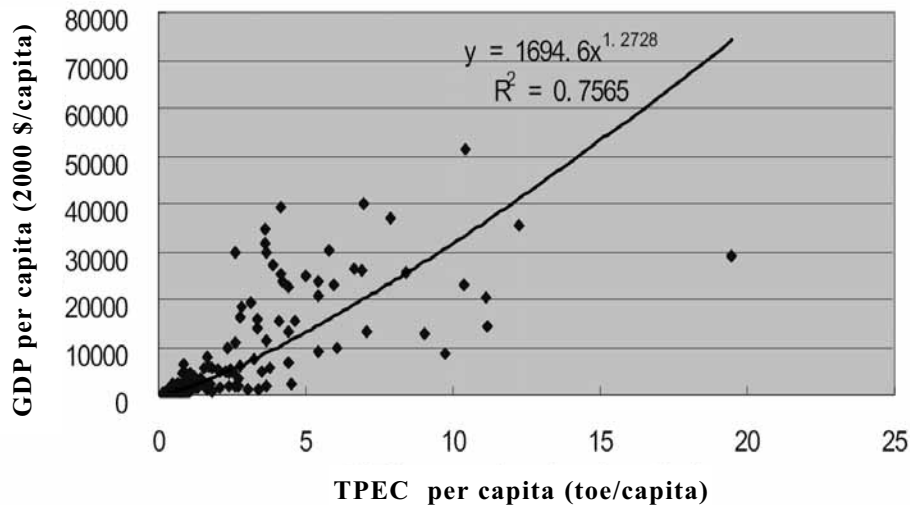


Fig. 3 - Correlation between GDP and total primary energy consumption (TPEC) per capita (5)

For every country, after economy development reaches to some level, energy consumption per capita will maintain a certain level. Generally speaking, energy consumption per capita will experience a rapid growth period with the rapid increase of economy, then gradually tend to slow, and finally stabilize at a certain level.

So, economic development and social progress in China mean a prominent increase in energy demand in China. It is out of doubt that as the most populous and most rapid growing countries, China will play an important role in world economy and energy at present and in the future (3).

### **Fast economy growth and social progress in China**

In the 21st century, China has entered a pivotal period of development. During this period, the various infrastructure facilities of economic development have been greatly improved, China is undergoing accelerated industrialization stage and has had stronger and stronger international competitive power. As a result, the rapid development of aviation industry and space technology sent the first astronaut into outer space at the end of 2003, which made China becoming the third country sending human into space successfully in the world.

In 2008 China became the first country with most internet users (220 million) in the world (7), which indicates a high modernization level of public administration and strong cultural diffusion among younger families.

The construction of Three Gorges Dam makes the Chinese hydraulic work remarkable in the world. As the longest dam in the world (the length of 3035 m, the height of 185 m), the Three Gorges Dam has integral functions in flood control, electric power generation and shipping. The Three Gorges Dam is also the world's largest hydro-electric power station with 18.2 GW of total capacity (8).

Great achievements are also made in the transportation sector, in which an outstanding one is the construction of the longest bridge in the world (36 km) crossing Hangzhou Bay area and connecting Shanghai and Ningbo City (inaugurated on May 1st 2008). The other prominent progress of transportation is the construction of magnetic suspension train leading to Pudong International Airport in Shanghai in 2003, which can reach the speed of 430 km/h. This dynamic modernization is also reflected by the profound change of large cities (appearance of skyscrapers, construction of more modern facilities).

Table 1 shows annual growth rate of GDP and GDP per capita in China and world from 1990 to 2005.

TABLE 1  
**GROWTH RATE OF GDP AND GDP PER CAPITA  
IN CHINA AND WORLD (9)**

| GDP            | Country/Region | China | World | Developing Countries        | Developed Countries   |
|----------------|----------------|-------|-------|-----------------------------|-----------------------|
|                | 1990           | 3.8   | 3     | 2.8                         | 3.1                   |
|                | 2000           | 8.4   | 4.9   | 6.1                         | 3.9                   |
|                | 2003           | 10    | 4.1   | 6.7                         | 1.9                   |
|                | 2004           | 10.1  | 5.3   | 7.7                         | 3.2                   |
|                | 2005           | 10.2  | 4.9   | 7.4                         | 2.6                   |
|                |                |       |       |                             |                       |
| GDP per capita | Country/Region | China | World | Medium-low income countries | High income countries |
|                | 2000           | 7.6   | 2.7   | 3.9                         | 2.8                   |
|                | 2001           | 7.5   | 0.3   | 1.8                         | 0.4                   |
|                | 2002           | 8.4   | 0.6   | 2.3                         | 0.7                   |
|                | 2003           | 9.3   | 1.5   | 4                           | 1.4                   |
|                | 2004           | 9.4   | 2.9   | 5.9                         | 2.6                   |
|                | 2005           | 9.2   | 2.4   | 5.2                         | 2.1                   |

According to the present growth rate, GDP in China will exceed the United States in 2030 and China will become the first-biggest country with total economic output in the world. Economic growth will be directly reflected in the people's life level. The data provided by National Economic and Social Development Statistical Bulletin of China show that “Engel coefficient” of Chinese urban and rural residents have decreased from 38.2 and 47.7 in 2001 to 36.7 and 45.5 in 2005 respectively (10). The consumption patterns of residents change from meeting basic survival needs to pursuit of the quality of life, housing, communications, motorization, tourism, are becoming the new hot spots of consumption.

FAO statistics show that since the 1980s, the nutrition structure and the quality of food consumption of Chinese people have been rapidly improved (11). Based on nutrition standards recommended, the calorie per

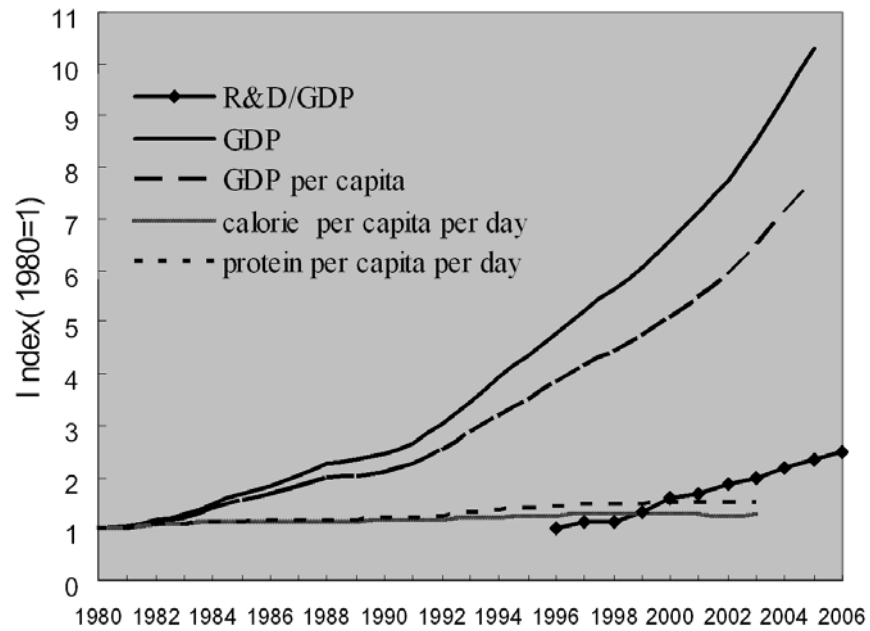
capita level of the residents has reached a reasonable nutrition requirement in 1984, and has been much more than nutrition requirement after 2000. Residents' nutrition structure is continuously improving, the intake of protein per capita exceeded obviously the nutritional standards recommended after 1990 (12).

The improvement of transportation network, sustained and rapid development of the national economy and the continuous improvement of people's life quality have contributed to the rapid growth of private cars. The total number of private cars in China has reached 23.33 million at the end of 2006, with an average annual increase of 24.6 % and a growth ratio of 140.8% to 2002 (13).

Rapid growth of the economy drives the social progress in China and China is more and more close to international standards. As we mentioned above, till the February 2008, the number of internet users in China is 0.22 billion, which has surpassed that of USA, and becomes the biggest country of internet in the world.

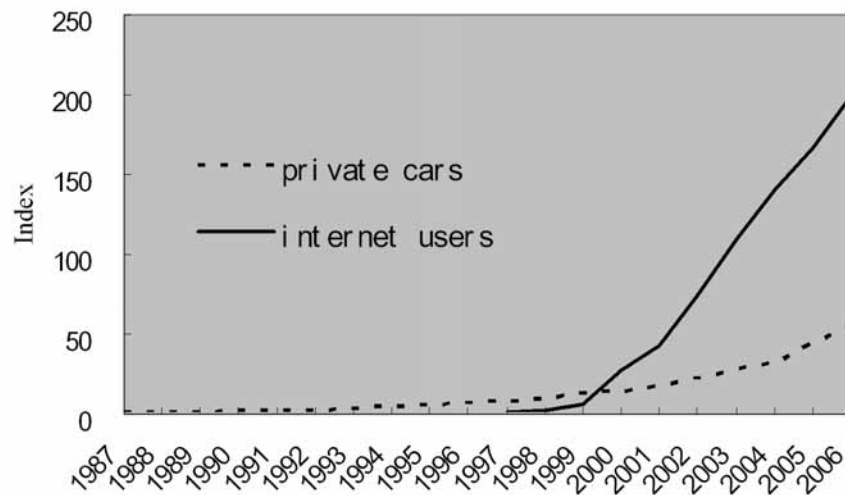
The ratio of Research and development (R&D) funding in GDP is an indicator reflecting the economic manner and the concentration level of one country, and become the core indicator of many countries and international organizations for evaluation of competitive strength of science and technology. In the 1990s, the ratio of R&D expenditure in GDP in China has been about 0.7%, and began to rise rapidly after 2000 and increased to 1.33% in 2005 (9), which is in the forefront of developing countries. Continuous rise of the intensity of R&D expenditure becomes an important guarantee for high innovation capability in China.

Figure 4 shows the growth process of some socio-economic indicators in China since 1980.



(Figure 4.1) \*

\*for the index of R&amp;D/GDP : 1996 = 1



(Figure 4.2) \*\*

\*\*for index of internet user : 1997 = 1

Fig. 4 - Growth process of Chinese economic and social indicators since 1980.

In 2003, Chinese GDP exceeded 11 trillion RMB and GDP per capita exceeded 1000 US dollars for the first time. Economics research tells us: When a country's GDP per capita is between 1,000 US dollars and 3,000 US dollars, social structure is usually adjusted intensely, social demand structure and industrial structure will change greatly (14).

As shown in Figure 5, growth of GDP and energy consumption in China fluctuated continuously between 1980 and 2005. During 1981-1984 and 1990-1992, average annual growth rate of GDP increases significantly and stabilize at about 10% after 1996. In this period the most prominent is the growth of primary energy consumption after 1999, average annual growth rate of which far exceeded that of GDP, and reached the highest level of 18% in 2004.

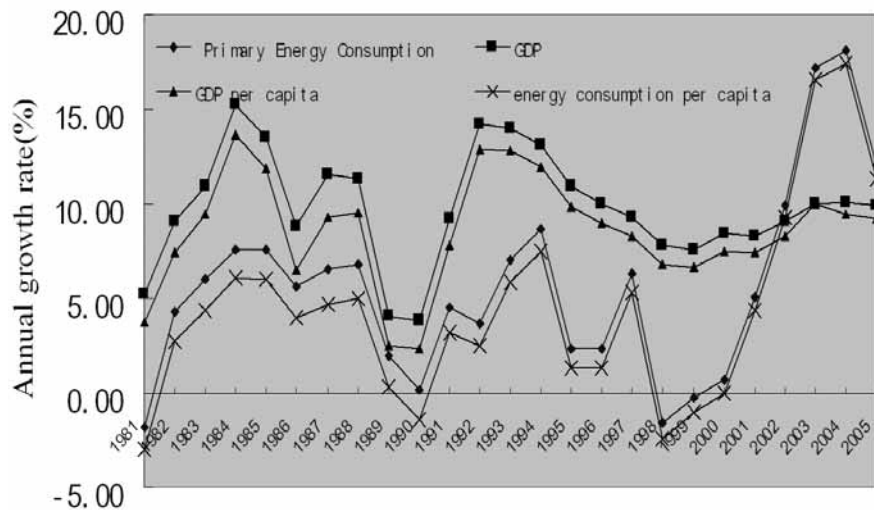


Fig. 5 - History of economy and energy growth in China (9) (15)

From 2001 to 2005, energy consumption of the world increased 1405Mtoe, and for China that is 338Mtoe, the share of Chinese increase in the world is 24%, which prove the importance of Chinese energy consumption increase to world energy consumption.

For consumption per capita between 2001 and 2005, it increases from 1.64 toe/capita to 1.78 toe/capita in the world and from 0.90 toe/capita to 1.32 toe/capita in China. The growth rate is 8.5% and 46.7% respectively (Table 2).

TABLE 2

**POPULATION AND ENERGY CONSUMPTION IN CHINA AND  
WORLD 2001-2005 (16)**

| year | Population<br>(million) |       | Energy<br>consumption per<br>capita (toe/capita) |       | GDP<br>(billion 2000\$) |       | Energy<br>consumption<br>(Mtoe) |       |
|------|-------------------------|-------|--------------------------------------------------|-------|-------------------------|-------|---------------------------------|-------|
|      | world                   | China | world                                            | China | world                   | China | world                           | China |
| 2001 | 6102                    | 1278  | 1.64                                             | 0.90  | 34399*                  | 1282* | 10029                           | 1397  |
| 2002 | 6195                    | 1287  | 1.65                                             | 0.97  | 35317*                  | 1381* | 10230                           | 1554  |
| 2003 | 6268                    | 1295  | 1.69                                             | 1.1   | 33391                   | 1550  | 10579                           | 1426  |
| 2004 | 6352                    | 1303  | 1.77                                             | 1.25  | 35025                   | 1904  | 11223                           | 1626  |
| 2005 | 6432                    | 1311  | 1.78                                             | 1.32  | 36281                   | 2098  | 11434                           | 1735  |

\*:billion 1995\$

Overall, Chinese energy consumption is closely linked with economic growth, when energy consumption grows rapidly, economy also grows rapidly.

**Energy consumption intensity — one of important bottlenecks restricting development of China**

Energy intensity is the input of energy per GDP, and is an integrated indicator measuring the level of energy utilization in a country or region. Change of energy intensity is closely related to the industrialization process. With the growth of economy, energy consumption usually rise continually during the early and medium stage of industrialization. When economic development has entered the post-industrial stage, economic growth mode changes greatly and energy consumption begins to decline (17).

Although since 1980 Chinese energy consumption intensity has declined fast (Figure 6), it still remained 0.89 toe / 103 (2000 \$) in 2005, which is far higher than the world average level of 0.32 toe / 103 (2000 \$) (Figure 7), and is 3.9 times of the United States , 5 times of Italy, 7.9 times of Japan, 7.3 times of Switzerland (15). Along with the further adjustment

of industrial structure and increase of energy efficiency, energy consumption intensity in China will gradually decrease, while it will take some time to keep up with the developed countries' level.

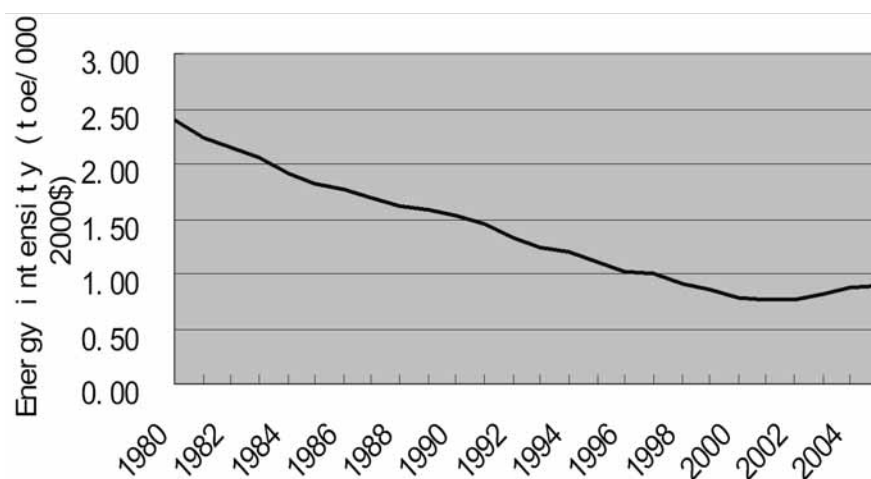


Fig. 6 - Energy intensity in China from 1980 to 2005

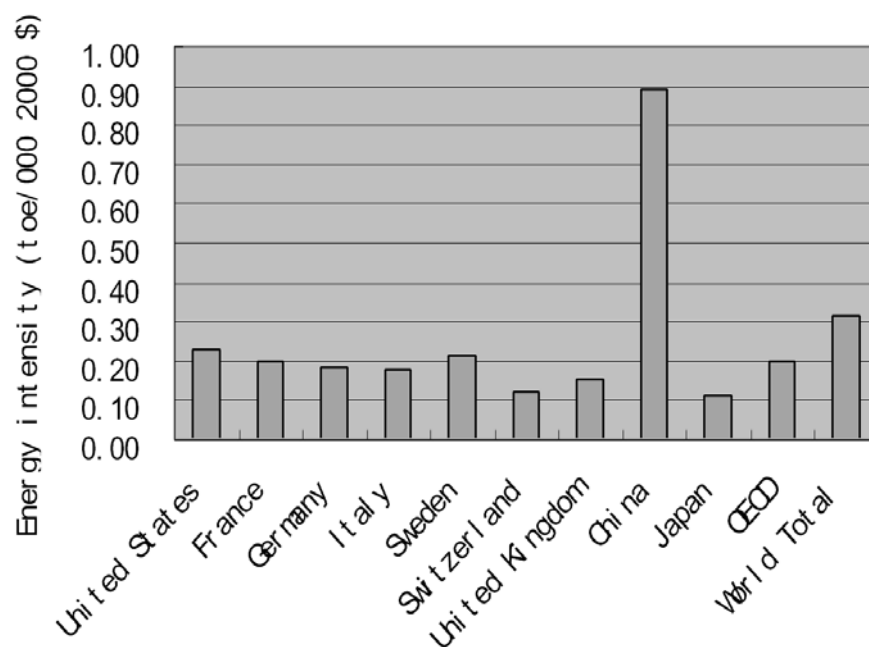


Fig. 7 - Energy intensity in world and many countries in 2005.

Figure 8 shows energy intensity in different regions of China in 2000-2005. We can see that energy intensity of Chinese Northeast and the West is significantly higher than that of the Eastern region and the national average level.

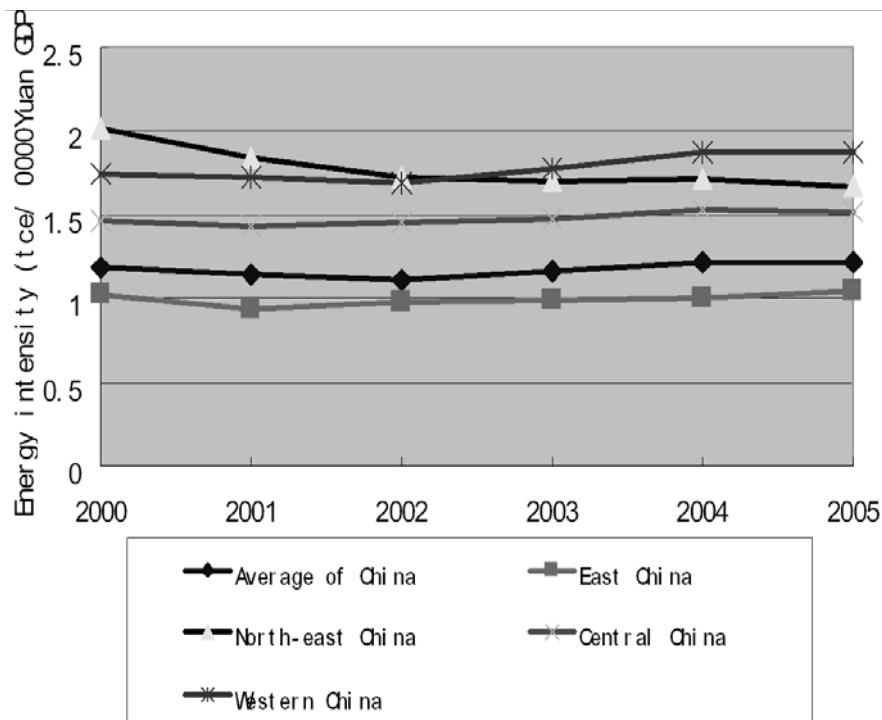


Fig. 8 - Energy intensity by regions in China in 2005.

### CO<sub>2</sub> emission – One of important environmental problems related with energy consumption

Environmental problems related with energy utilization are very complicated. Energy production and consumption can cause not only regional environmental problems such as air pollution, acid rain, deforestation etc. but also global environmental problems such as climate change, ozone depletion etc. China is a large energy producer and consumer country (Table 3), and also takes coal as the main energy source. Coal consumption is the main cause of smoke pollution, as well as the main source of greenhouse gas. Coal-based energy structure in China can cause large emission of CO<sub>2</sub> (Table 4).

TABLE 3

**PRODUCTION AND CONSUMPTION OF COAL IN  
THE PRINCIPAL COUNTRIES**

| Country        | Coal: Production (Mtoe) |       |        |                 | Coal Consumption (Mtoe) |       |        |                 |
|----------------|-------------------------|-------|--------|-----------------|-------------------------|-------|--------|-----------------|
|                | 1985                    | 1995  | 2005   | Annual rate (%) | 1985                    | 1995  | 2005   | Annual rate (%) |
| USA            | 487.0                   | 555.1 | 580.2  | 0.9             | 440.4                   | 506.2 | 574.2  | 1.3             |
| Canada         | 33.7                    | 40.8  | 34.0   | 0.1             | 29.3                    | 25.2  | 32.5   | 0.5             |
| France         | 10.2                    | 5.3   | 0.2    | -17.0           | 23.0                    | 14.5  | 13.3   | -2.7            |
| Germany        | 144.8                   | 74.6  | 53.2   | -4.9            | 147.6                   | 90.6  | 82.1   | -2.9            |
| United Kingdom | 54.9                    | 31.8  | 12.5   | -7.1            | 62.9                    | 47.5  | 39.7   | -2.3            |
| Australia      | 88.3                    | 129.4 | 206.5  | 4.3             | 30.1                    | 41.1  | 52.5   | 2.8             |
| China          | 439.8                   | 686.3 | 1119.8 | 4.8             | 410.7                   | 694.6 | 1095.9 | 5.0             |
| India          | 74.2                    | 135.2 | 200.7  | 5.1             | 77.4                    | 142.8 | 222.0  | 5.4             |
| Japan          | 9.6                     | 3.4   | 0.6    | -12.9           | 73.7                    | 86.2  | 121.3  | 2.5             |
| TOTAL WORLD    | 2092                    | 2257  | 2917   | 1.68            | 2075                    | 2285  | 2957   | 1.79            |

TABLE 4

**CO<sub>2</sub> EMISSION COEFFICIENT OF FOSSIL FUEL (18)**

Unit: tc/tce

| Type                 | Coal | Oil  | Natural gas |
|----------------------|------|------|-------------|
| Emission coefficient | 0.76 | 0.59 | 0.45        |

With coal as the main energy, consumption of coal in China has still continued to increase in recent years. Although desulfurization equipments have been started in new-built coal-fired power plants, pollution problems (especially air pollution ) caused by the burning of coal have not mitigated effectively.

Figure 9 shows the history of primary energy consumption structure in China (1965-2005), in which we can see the absolute position of coal consumption in China's primary energy consumption. For quite a long period of time, coal will remain as China's basic energy, coal consumption will continue to increase, which will make China facing great difficulty to control air pollution.

In 2005 sulphur dioxide emission in China was 2549.3 million tons, increasing 27% since 2000 (19). Environmental pollution from fossil fuel consumption is damaging human health, air and water quality, and agriculture (20). Because of rapid growth of energy consumption especially coal consumption, many of China's cities are among the most polluted in the world.

China has become the world's second-largest source of carbon dioxide emission behind the United States (Figure 10) (21). As one of contracting parties of "Kyoto Protocol", Chinese government is actively making various measures through economic and political means to adjust energy structure and apply advanced technologies, to reduce CO<sub>2</sub> emission and promote the coordinated development of energy and environment finally (22).

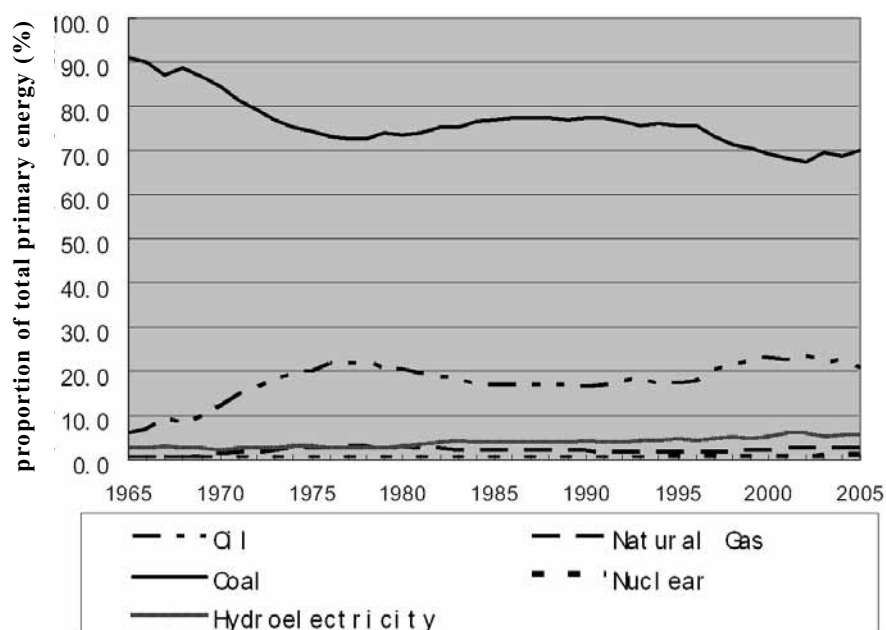


Fig. 9 - History of primary energy consumption structure in China (1965-2005)

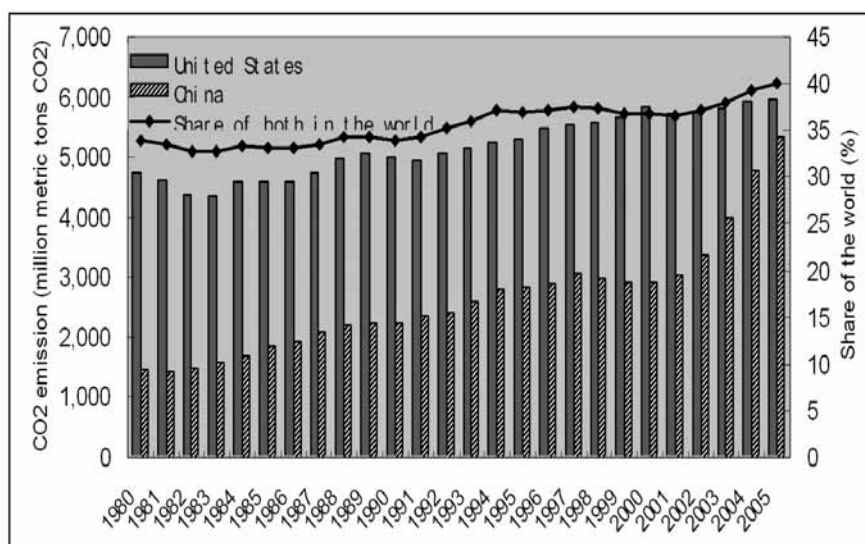


Fig. 10 - CO<sub>2</sub> emission in China and USA from 1980 to 2005 (15).

## **Conclusion**

Since 1980s, the policies of government of the People's Republic of China have been particular effective in ensuring economic development, growth in material consumption and enhance of well-being of population. As a result, the average annual growth rate of GDP between 1980 and 2005 was 10.7%, which is far higher than that of developed countries, and is accompanied with an average annual growth rate of population limited to 1.1%. According to the present growth rate, GDP in China will exceed the United States in 2030 and China will become the largest economy body in the world.

Obviously, the positive results would not be achieved without a substantial increase in total and per capita energy availability supported by a series of planning from the Chinese government. While based on the present economic development level and technological condition, increasing of energy consumption will cause a growing of environmental pressure not only reflected at the local level but also involved on the sphere of global environmental change.

It is not so easy for China to find a good solution to mitigate environmental problems and meanwhile to satisfy the necessity of enlarging economy and improving the quality of life for the increasing population.

While it is fortunate to see that the Chinese government and people are increasingly sensitive in decreasing energy intensity, preference of renewable resources if possible, utilization of systems removing pollutants, CO<sub>2</sub> and other greenhouse gases, to obtain the growth of GDP. That is also consistent with signing of "Kyoto Protocol" by the Chinese government, which allows us to view Chinese future with more confidence.

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