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28. INCOME DISTRIBUTION

Inequality in China

Income Distribution Data and Chart

“Income Distribution in Chinese Society,” Xiazhun Liu.

Inequality in China

Overview

In the transformation from a communist state-controlled economy to a more socialist market economy, China has managed to attain remarkable rates of growth. However, as in other countries, economic market-based reforms succeed largely by making remuneration reflective of productivity and establishing proper incentives based on market-based price signals. The returns to capital and land have risen, employment has become more diversified, and factor mobility has increased. As a result, in moving from a system based on equitable redistribution, income inequality has risen in China as those who were best positioned to benefit from the reforms—generally the educated and the enterprising, the mobile, and those with high-quality land—have seen their incomes grow faster than others. Nevertheless, China's rapid growth has made substantial gains in alleviating poverty: since the start of reforms in 1978, an estimated 200 million people have been lifted out of absolute poverty.

To some extent, therefore, inequality has been the price of the growth bought by economic reform. However, government policies have also contributed to the rise in inequality. In general, social policies favor urban areas over rural areas, economic policies favor coastal regions over the interior, and access to education and health care remains as unequal. China's income inequality is still moderate, but it has been growing quickly. In other countries inequality has impeded growth, undermined poverty alleviation, and led to social unrest. Thus, inequality is of concern in the context of maintaining support for China's current movement toward economic and political reform.

Trends

China's income distribution has become increasingly unequal since the start of reforms in 1978. The Gini coefficient has risen from a low 28.8 in 1981, to a moderate 38.8 in 1995 (similar to that of the United States and near the East Asian average). While the current level of inequality is not remarkable, its growth certainly is (the change in the Gini coefficient having outpaced those of almost all other countries during the same period). Since 1980, the distribution of income has evolved in three distinct periods:

- Between 1981 and 1984, there was a 12.6% per year (real) increase in the mean income, while the distribution of income remained roughly similar in shape.
- 1984 to 1989 saw a rise in inequality with little rise in mean income, as the rich got richer and the poor got poorer.
- Since 1990, renewed growth in personal incomes has been associated with substantial increases in inequality. (During this time the Gini coefficient rose from 33.9 to 38.8, as the distribution of income has both shifted right and flattened somewhat.)

Income inequality has risen along two dimensions: between rural and urban areas, and between the coast and the interior. In addition, the access to opportunities to improve incomes and welfare is becoming less uniform, suggesting that inequality will continue to grow in the future. This *inequality in opportunity* is arising both out of more market-based institutional financing, in which an emphasis on cost recovery encourages selective allocation of educational and health resources, and through gender bias. There is evidence that families invest less in girls' than boys' education and health.

The widening gap between China's *rural and urban* incomes is the biggest contributor to increased inequality, accounting for more than 50 percent of inequality in 1995, and explaining 75 percent of the increase since 1984, according to Chinese data adjusted by the World Bank for cost-of-living and in-kind income. Rural incomes were only 40 percent of urban incomes in 1995 (non-adjusted). Suggested explanations for the widening gap are imperfect labor mobility (caused both by informational and physical costs of urban emigration, and by the government's desire to control the pace of emigration and ensure grain self-sufficiency) and government policies that prop up the urban standard of living.

In addition, there has been a marked divergence in the per-capita incomes of the *coastal and interior* regions. The deviation is larger for rural than urban incomes, but both are growing. In 1992 average incomes in coastal China were 50 percent higher than in the interior. Provincial income disparities are increasing for several reasons. Since the start of reforms, coastal provinces have grown faster—and at an accelerating pace—than interior ones, due to a combination of initial conditions, natural endowments and preferential policies. Education and health indicators, which have always been better on the coast, have grown relative to the interior. Per-capita investment levels on the coast are 2½ times higher than those in the interior. The share of investment in state-owned enterprises is lower in the coast, while the share in fast-growing industries is higher. Foreign direct investment and trade also play a greater role in the coastal regions than in the interior. This is due in part to natural endowments, but it also reflects preferential government investment policies and a disproportionate allocation of credit to the coastal regions.

Decentralization of the fiscal system has fueled the above disparities in two ways. It has increased the emphasis on cost recovery for social services, which reduces the poor's access to these services. It also has meant that richer provinces can spend more than poorer ones—for health, education, and infrastructure—further boosting their growth prospects. China's intergovernmental fiscal transfer scheme, which was equalizing in the 1980s, has not kept pace with the rising regional disparities.

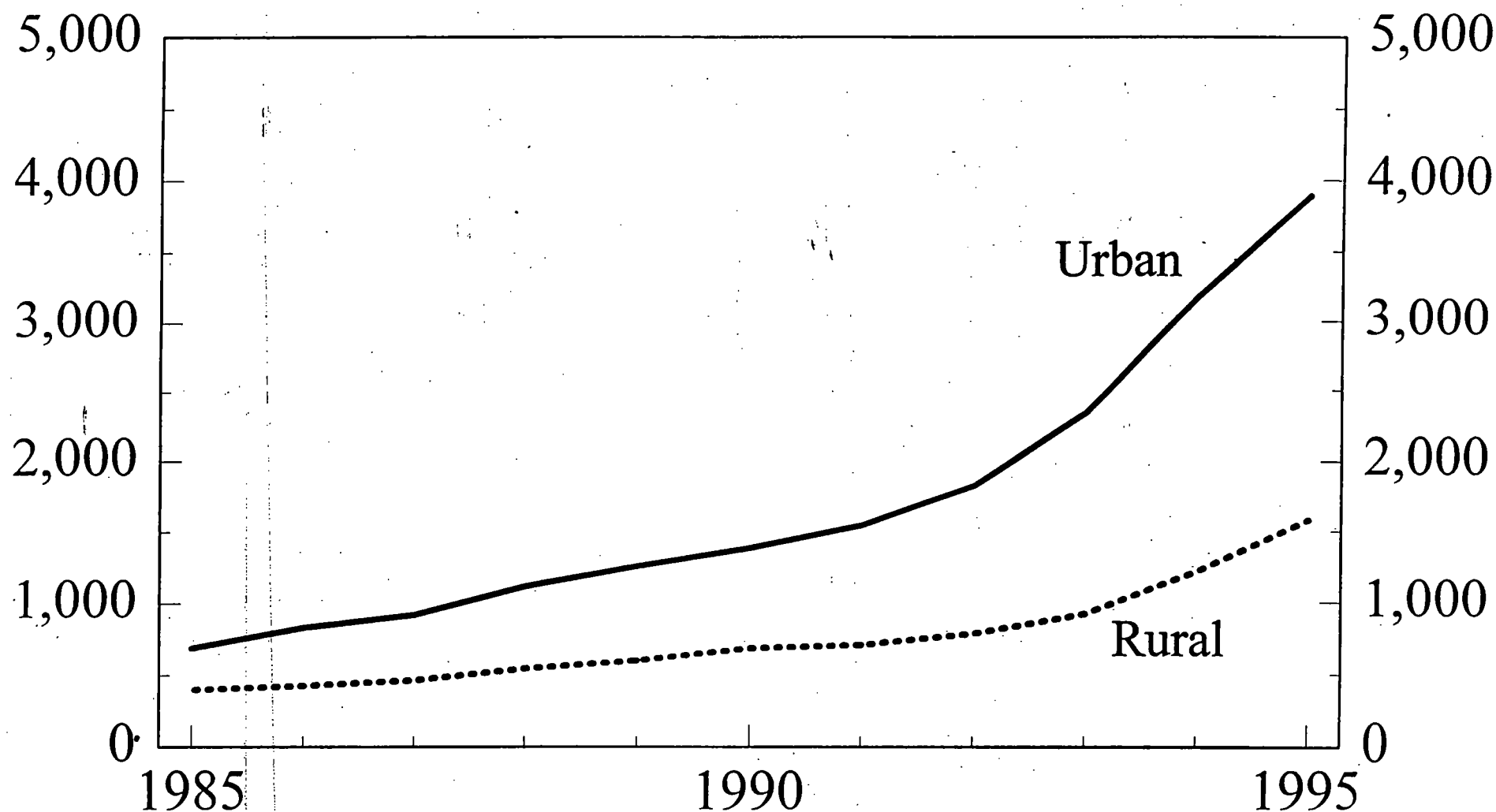
INCOME DISTRIBUTION

In the early years of China's economic reform, rural income gains exceeded those in urban areas. The ratio of urban per capita GDP to rural per capita GDP fell from 2.4 in 1978--the first year of the reform--to 1.7 in 1985. Since then, the trend has been reversed, with the ratio rising steadily from 1.7 in 1985 to 2.5 in 1995. The major reason for this widening income gap is that growth in agricultural production has slowed after several years of large gains at the beginning of the agricultural reform.

The income disparities among regions are also substantial. In general, incomes in coastal regions are much higher than those in the interior. In 1995, the per capita GDP of Shanghai, a coastal city and the richest city in China, was 10.2 times of that of Guizhou, an interior province and the poorest one in China. In comparison, the ratio was 7.4 in 1990. To alleviate the disparities among regions, the Chinese government plans to step up infrastructure investment in the interior.

China: Urban and Rural Per Capita Incomes

(Yuan per year)



Source: China Statistical Yearbook

4. INCOME DISTRIBUTION IN CHINESE SOCIETY

Xiaozhu Liu¹

This paper surveys several aspects of income distribution in China. It focuses on the patterns of income disparity between different regions, between urban and rural populations, and between individuals—including the new rich and the poor. Reasons for the observed distribution of income in China are discussed, including a number of factors such as historical, geographic, climatic, and environmental conditions; the effects of state policies; and different economic and industrial structures. The paper concludes with a discussion of how the problems of excessive income disparity might be addressed within a democratic framework.

INCOME GAPS ACROSS DIFFERENT REGIONS

Regional Per Capita Income Gaps

One method commonly used to evaluate the level of economic development of a region is to compare regional gross domestic product (GDP) per capita to the national average. A study conducted by a research group at the Chinese Academy of Sciences (Hu 1994) used this method to divide China's provinces (including the autonomous regions, ARs) and municipalities (Shi) into four income groups: low (below 75 percent of the national average GDP per capita), lower-middle (between 75 percent and 100 percent of the national average GDP per capita), upper-middle (100-150 percent of the national average GDP per capita), and high (above 150 percent of the national average GDP per capita).

Based on GDP per capita in 1991 (and arranged in ascending sequence), the low income group consisted of 10 provinces: Guizhou, Anhui, Guangxi AR, Gansu, Henan, Yunnan, Sichuan, Jiangxi, Hunan, and Shaanxi; the lower-middle income group consisted of 9 provinces: Tibet AR, Ningxia AR, Inner Mongolia AR, Shanxi, Hebei, Hubei, Qinghai, Hainan, and Jilin; the upper-middle income group consisted of 6 provinces: Fujian, Shandong, Xinjiang AR, Heilongjiang, Jiangsu, and Zhejiang; and the high income group consisted of 2 provinces and 3 independent cities (municipalities): Liaoning, Guangdong, Tianjin Shi, Beijing Shi, and Shanghai Shi. (For the location of these provinces, autonomous regions, and municipalities, see the map of administrative regions of China on page xiii of this volume.)

The average GDP per capita for the low income group was 1,126 yuan or 64.0 percent of the national average; for the lower-middle income group, 1,526 yuan or 86.9 percent of the national average; for the upper-middle income group, 2,010 yuan or 114.4 percent of the national average; and for the high income group, 3,346 yuan or 190.3 percent of the national average. The average GDP per capita for the high income group was three times as much as that for the low income group. The low income group of provinces and autonomous regions made up a much larger proportion of the nation's total population compared to its share of national GDP, whereas the opposite was the case for the high income group.

According to Hu (1994), overall regional (provincial) deviations of GDP per capita from the national average declined over the period 1978-91, but is expected to rise slightly by the year 2000. The difference between the region with the highest GDP per capita and the region with the lowest GDP per capita also declined over the same period from 14.3 times to 7.5 times and is expected to continue to decline to 7.0 times by the year 2000.

The current level of economic development of a region is related to its contemporaneous characteristics and its development history. Regional differences in natural, geographical, and ecological conditions have given rise to unequal starting points for economic development. While the overall rate of growth of China over the past decade has been impressive, regional differences have also grown. For example, consider the municipality of Shanghai Shi and the province of Guizhou, which had, respectively, the highest and the lowest GDP per capita in the country in 1991. During the past decade of reform, both have witnessed relatively high growth rates of GDP per capita. From 1978 to 1991, the growth rate of GDP per capita in Guizhou was 7.7 percent while that of Shanghai Shi was 7.6 percent. However, there was a large gap in GDP per capita of 2,323 yuan at the starting point in 1978 (GDP per capita in Guizhou was 175 yuan, whereas that in Shanghai Shi was 2,498 yuan), and this difference increased to 5,785 yuan by 1991 (GDP per capita in Guizhou went up to 890 yuan in 1991, whereas in Shanghai Shi it went up to 6,675 yuan). It is predicted that by the year 2000, the gap will widen to 10,400 yuan (Hu 1994; see also SSB 1990).

Provincial differences in GDP per capita feed into regional differences, particularly between the eastern and the western regions in China. As the saying goes in China's academic circles, globally the income gap is a North-South issue, but in China it is an East-West issue, where the difference between the eastern and western regions refers mainly to the difference between the coastal and inland regions. It is widely recognized that since reform, the gap in economic development between the coastal

region of the East, on the one hand, and the inland regions of the Central and West, on the other, has widened.

In the early 1990s, the provinces that achieved a rapid rate of growth were those situated along the eastern coastline. Before the reforms, the three eastern municipalities of Tianjin Shi, Beijing Shi, and Shanghai Shi, and the three provinces in the Northeast (Heilongjiang, Jilin, and Liaoning) enjoyed a more sophisticated industrial infrastructure and were relatively well-developed compared to the other coastal provinces. In 1953, the eight provinces and independent cities (municipalities) with the highest GDP per capita were Shanghai Shi, Tianjin Shi, Beijing Shi, Liaoning, Heilongjiang, Inner Mongolia AR, Xinjiang AR, and Jilin. In 1978, the eight provinces and independent cities with the highest GDP per capita were Shanghai Shi, Beijing Shi, Tianjin Shi, Liaoning, Heilongjiang, Jiangsu, Qinghai, and Jilin. By the early 1990s, some of the other coastal provinces (Guangdong, Shandong, Jiangsu, and Zhejiang) had caught up. In 1992, the eight provinces and independent cities with the highest GDP per capita were Shanghai Shi, Beijing Shi, Tianjin Shi, Guangdong, Liaoning, Jiangsu, Zhejiang, and Shandong. The East now accounts for a greater share of China's GDP, having risen from 52.2 percent in 1980 to 55.8 percent in 1992. Meanwhile, the shares accounted for by the Central and the West have shrunk. The growth rate in the East has been higher than the national average, while those of the Central and the West have been below (SSB 1994; see also Zhuo 1993).

Within the East, there are also differences in income between the southern and the northern areas. The three provinces in the Northeast (Heilongjiang, Jilin, and Liaoning) have lagged behind the five provinces in the Southeast (Shandong, Jiangsu, Zhejiang, Fujian, and Guangdong). From 1978 to 1992, the annual average increase of GDP in the Northeast was 7.4 percent, compared to 11.9 percent in the Southeast. The 4.5 percentage-point difference has led to a reversal in the relative levels of development for these two eastern subregions. Such a change in economic strength reflects differences in their economic structures and warrants further study.

From 1949 to the beginning of the reform, the three provinces in the Northeast built up a relatively strong industrial base, thanks to substantial existing investments that had been made under Japanese colonial rule. After the People's Republic of China was founded, further investments enabled the Northeast to become an important industrial center and to maintain a relatively high level of income per capita. In contrast, for many years most areas along the southeastern coastline were not well developed. Although there existed advanced metropolitan economies in Shanghai Shi and Tianjin Shi, such development—which can be attributed mainly to investment by

ern countries and domestic investors—was not representative of the founding areas of these cities and the southeastern coastal region in general. Before the reform, the economies of most provinces along the eastern coastline had been at the middle or the lower-end of the national income scale.

During the past decade of reform, the five provinces along the eastern coast were not only the fastest-growing area in the East, but also the fastest-growing area in the whole country. The income gap between the five provinces in the Southeast as a group and most other provinces in the country narrowed. In 1978, GDP per capita was 539.1 yuan in the Northeast, 351.2 yuan in the Southeast; by 1992, GDP per capita had grown to 1,377 yuan in the Northeast and to 1,390 yuan in the Southeast (Zhuo 1993; 1994).

Reasons for Regional Per Capita Income Gaps

Reasons for regional differences in per capita income in China are very complex. I will focus on five major factors: (a) natural, geographic, climatic, and environmental conditions; (b) effects of government distribution and investment policies; (c) the industrial structure of the regional economies; (d) involvement in international trade; and (e) the different paths of economic reform.

Natural, Geographic, Climatic, and Environmental Conditions. As China is still at the initial stage of industrialization, economic development is noticeably affected by natural endowments and geographical conditions in every region.

There are great differences in climatic conditions across regions in China. In the early 1980s, scientists divided China into three natural climatic zones: the eastern monsoon region (which accounts for 47.6 percent of China's total land area), the northwestern drought region (which accounts for 22.6 percent), and the southwestern Qinghai-Tibet cold plateau region (which accounts for 29.8 percent). The eastern monsoon region has over 92 percent of the country's total arable land, while the northwestern drought region and the Qinghai-Tibet cold plateau region together have only 8 percent. The differences in the natural climatic conditions across the three regions are due to the geographical distribution of China's population, with over 90 percent of the country's total population residing in the eastern monsoon region and less than 5 percent of the country's total population residing in the other regions (Chen and Hu 1983).

Environmental conditions also have an impact upon the regional economies. Most underdeveloped areas and provinces with a relatively low

GDP per capita are located in environmentally fragile areas with harsh natural conditions—such as the rocky karst areas (irregular limestone regions with sinks, underground streams, and caverns) in the Southwest. In the southwestern province of Guizhou, mountains make up 87 percent of the total area, hills 10 percent, and arable land only 3 percent. This province had the lowest GDP per capita during the 1978-1991 period. Other provinces with similar rocky karst topology also have low per capita incomes (e.g., Guangxi AR, Yunnan, Sichuan, and Hunan).

Most underdeveloped provinces are located inland and their transportation and communication facilities lag behind most other provinces. In particular, the lack of sea access has had a considerable negative impact upon economic development of some areas. For example, among the low-income provinces, only Guangxi AR has seaports. Similarly, among the nine lower-middle-income provinces, only Hebei and Hainan have seaports. In contrast, among the six upper-middle-income provinces, all but Xinjiang AR and Heilongjiang have seaports; among the five high-income provinces and independent cities (municipalities), all except Beijing Shi have seaports (Chen and Hu 1983; see also CDFA 1984).

Effects of Government Distribution and Investment Policies. Preferences or prejudices embodied in central government distribution and investment policies have a direct impact upon developmental differences across the regions. Since the developed areas along the coastline enjoy both geographic and political advantages, most foreign investment also goes to the coastal areas. Foreign investment in underdeveloped inland areas constitutes only a small share and even this small share has been on a decline. In 1992, the share of the nation's total direct foreign investment accounted for by the high-income group was 47 percent, with Guangdong Province alone accounting for 33.6 percent. For the same year, the share of total direct foreign investment accounted for by the upper-middle income group was 38.2 percent, while the lower-middle income group accounted for 8.2 percent, and the low-income group accounted for 6.6 percent (SSB 1994).

Lack of capital is becoming increasingly evident in underdeveloped areas. The level of investment per capita in underdeveloped areas is below the average for the nation as a whole. In 1992, investment per capita in the ten low-income provinces was 60 percent below the national average. In contrast, investment per capita in the high-income provinces was significantly higher than the national average. For example, investment per capita was 2.1 times the national average in Guangdong, 3.6 times in Beijing Shi, and 4.0 times in Shanghai Shi (SSB 1994).

Regional Industrial Structures. Differences across regions in industrial structure contributes to per capita income disparity among regions.

Western countries and domestic investors—was not representative of the surrounding areas of these cities and the southeastern coastal region in general. Before the reform, the economies of most provinces along the southeastern coastline had been at the middle or the lower-end of the national income scale.

During the past decade of reform, the five provinces along the southeastern coast were not only the fastest-growing area in the East, but also the fastest-growing area in the whole country. The income gap between the five provinces in the Southeast as a group and most other provinces in the country narrowed. In 1978, GDP per capita was 539.1 yuan in the Northeast and 351.2 yuan in the Southeast; by 1992, GDP per capita had grown to 1,247 yuan in the Northeast and to 1,390 yuan in the Southeast (Zhuo 1993; SSB 1994).

Reasons for Regional Per Capita Income Gaps

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Natural, Geographic, Climatic, and Environmental Conditions. As China is still at the initial stage of industrialization, economic development is appreciably affected by natural endowments and geographical conditions of a given region.

There are great differences in climatic conditions across regions in China. In the early 1980s, scientists divided China into three natural climatic regions: the eastern monsoon region (which accounts for 47.6 percent of China's total land area), the northwestern drought region (which accounts for 29.8 percent), and the southwestern Qinghai-Tibet cold plateau region (which accounts for 22.6 percent). The eastern monsoon region has over 92 percent of the country's total arable land, while the northwestern drought region and the Qinghai-Tibet cold plateau region together have only 8 percent. The differences in the natural climatic conditions across the three regions contribute to the geographical distribution of China's population, with over 95 percent of the country's total population residing in the eastern monsoon region and less than 5 percent of the country's total population residing in the two other regions (Chen and Hu 1983).

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Regional Industrial Structures. Differences across regions in industrial structure contributes to per capita income disparity among regions.

In underdeveloped areas, the agricultural sector makes up a large portion of the economy. Industry, however, is the leading sector of economic growth nationally and has a greater impact upon GDP. For areas with a high increase of gross industrial output, the growth of GDP is also high. For example, from 1979 to 1992, the average annual increase of gross industrial output of Zhejiang Province was 21.1 percent, the highest in the nation; Guangdong Province was next with an average annual increase of 19.8 percent. The corresponding rates of growth for Jiangsu, Fujian, and Shandong Provinces were 18.5 percent, 18.3 percent, and 15.6 percent, respectively, all of which were higher than the national average of 13.2 percent. In contrast, Heilongjiang Province reported an increase of 7.1 percent, the lowest in the country. Due to such low increase, Heilongjiang fell from the high-income group of provinces to the upper-middle income group in 1992 (SSB 1994).

Light industry makes up over 36 percent of the total economy in the provinces and autonomous regions of Tibet AR, Guangxi AR, Hainan, Guizhou, Yunnan, and Ningxia AR, which belong to lower-middle or low income groups. On the other hand, in the provincial and municipal economies that belong to the high income group, light industry makes up only a small portion of the total economy. For example, light industry accounts for less than 10 percent of the total economy in Beijing Shi, Tianjin Shi, and Shanghai Shi, while it accounts for 15 percent in Liaoning and 20 percent in Guangdong.

The ratio of light industry to heavy industry within the industry sector also exerts an impact on development and income distribution. One of the most important characteristics of the traditional state-planning model was that heavy industry should make up a larger proportion of the industrial base than light industry. During the transition to a market-oriented economy, the relative importance of light industry has gradually increased. Hainan Province has the largest proportion of light industry (67.1 percent). The corresponding proportions for Guangdong, Zhejiang, Fujian, and Jiangsu are, respectively, 65.7 percent, 65.2 percent, 62.7 percent, and 53.2 percent, all above the national average of 48.9 percent. In the underdeveloped provinces of Shanxi, Gansu, and Qinghai, heavy industry makes up over 70 percent of the total industry sector (SSB 1994).

The industrialization of rural areas also has an impact on development. According to official statistics, in 1985, the non-agricultural output of rural areas made up 42.9 percent of the nation's gross value of output; by 1992, this share had gone up to 64.2 percent. Shanghai Shi had the highest proportion of non-agricultural output (88.2 percent), followed by Jiangsu with 80.9 percent, while the autonomous regions of Tibet and Xinjiang had

the lowest proportions (5.5 percent and 17.2 percent, respectively). With the exception of Shanxi and Hebei Provinces, the shares of non-agricultural output of all of the 17 underdeveloped provinces or autonomous regions were below the national average (SSB 1994).

International Trade. Involvement in international trade also affects the rate of economic development. Statistical data show that the greater the proportion of exports in GDP (the export dependency ratio), the higher the increase of GDP. The export dependency ratio reflects the degree of openness of a region. For example, in Guangdong Province, exports made up 44.3 percent of its GDP in 1992, the highest in the country; this was followed by Hainan Province with 34.3 percent. The export dependency ratios for Shanghai Shi and Fujian were 33.6 percent and 33.4 percent, respectively. At the other extreme, the exports of Guizhou Province made up only 3.7 percent of its GDP. The corresponding export dependency ratios for Sichuan, Henan, Shanxi, and Anhui were 5.5 percent, 5.9 percent, 4.2 percent, and 6.3 percent, respectively (SSB 1994).

Paths of Economic Reform. The growth of non-state-owned enterprises in the regional economies resulting from the reform process is especially consequential for per capita income distribution. Non-state-owned enterprises have increased rapidly and have become an important part of the current economic structure in China. From 1978 to 1992, non-state-owned enterprises contributed to 55.7 percent of the total increase in China's gross industrial output. In 1992, non-state-owned enterprises accounted for one-third of the fixed asset investment; in the agriculture and commerce sectors, they accounted for an even greater proportion (SSB 1994).

A nationwide study of the relationship between increases of GDP per capita and the percentage of non-state-owned enterprises found that these two measures were highly correlated (the correlation coefficient was 0.687) (Zhuo 1993). From 1978 to 1992, the five provinces in the Southeast that had the highest percentage of non-state-owned industry (above 60-70 percent) contributed to over 70 percent of the increase in gross industrial output (SSB 1994). On the whole, the provinces with a low rate of increase in GDP per capita also had a lower percentage of non-state-owned enterprises.

The growth of non-state-owned enterprises is also the major cause for the expansion of the gap between the East and the West as well as the reversal of the North-South difference within the East. The degree and pace of economic reform in the East (especially the Southeast) are considerably higher than in the Central and the West. From 1978 to 1992, the share of gross industrial output accounted for by non-state-owned enterprises in the East grew by 36.6 percent, 7.1 percentage points higher than the national average; in the Central and the West, it grew by 18.3 percent and 16.7

ercent, respectively—significantly lower than the East. In 1992, non-state-owned enterprises accounted for 61.4 percent of the gross industrial output in the East, 39.4 percent in the Central, and 34.7 percent in the West—only slightly over two-thirds and one-half, respectively, of the corresponding proportion in the East (SSB 1994).

The most salient feature of the underdeveloped areas is that they still operate within the state-planning economic model, and state-owned enterprises still form the bulk of their economies. The functioning of a market economy and the development of the non-state-owned sectors of the economy are still relatively weak in these areas, far behind the southeastern coastal provinces in terms of market reform. State-owned enterprises in the underdeveloped areas make up a larger portion of gross industrial output than non-state-owned enterprises. For example, in 1992, state-owned enterprises accounted for 82.4 percent of Qinghai's gross industrial output (0.7 percentage points higher than 1978); 70 to 80 percent of gross industrial output in the provinces of Ningxia AR, Inner Mongolia AR, Gansu, Yunnan, and Guizhou; and 60 to 70 percent of gross industrial output in Jilin, Hainan, Shaanxi, Hebei, Guangxi AR, Hubei, and Tibet AR. The state-owned enterprise share of gross industrial output for Qinghai and some other provinces was much higher in 1992 than it was in the southeastern coastal provinces of Zhejiang, Guangdong, Fujian, and Shandong in 1978 (SSB 1994; Zhuo 1993).

INCOME GAPS BETWEEN THE URBAN AND THE RURAL POPULATIONS

Income Gaps Between Urban and Rural Residents

Researchers and statisticians have used measures of disposable income to compare income differences between urban and rural residents. Disposable income is equivalent to the sum of consumption expenses and savings. Disposable income for rural residents is their net income (i.e., total family income of permanent rural residents less required expenses, taxes, and other contributions to fulfill the quotas of the collective), while for urban residents it is the sum of their living expenditure income (i.e., cash income) and non-cash income such as in-kind payments and other state subsidies (e.g., housing, medical expenses, and all other in-kind work-unit distributions).

From 1980 to 1993, the difference in disposable income between urban and rural residents at first fell but then increased (see Table 4.1). In 1980, the average disposable income for urban residents was 620.19 yuan and 191.33 yuan for rural residents; the average disposable income of urban

Table 4.1 Average Per Capita Disposable Income for China's Urban and Rural Residents, 1980-1993
(yuan/person)

Year	Urban Residents	Rural Residents	Ratio: Urban over Rural
1980	620.19	191.33	3.24
1981	681.71	223.44	3.05
1982	721.54	270.11	2.67
1983	770.36	309.77	2.49
1984	870.31	355.33	2.45
1985	967.20	397.60	2.43
1986	1143.49	423.76	2.70
1987	1268.66	462.55	2.74
1988	1477.70	544.94	2.71
1989	1704.68	601.51	2.83
1990	1921.96	686.31	2.80
1991	2148.52	708.55	3.03
1992	2484.24	783.99	3.17
1993	3070.90	921.40	3.33

Source: RITSSB (1995).

sidents was over three times that of rural residents. In the ensuing years, the difference fell gradually. By 1985, the average disposable income of urban residents was 967.20 yuan, compared to 397.60 yuan for rural residents (with urban residents' disposable income being 2.43 times that of rural residents). From the late 1980s onward, the gap widened again. In 1993, the average disposable income of urban residents was 3,070.90 yuan, compared to 921.40 yuan for rural residents, with urban residents' disposable income being 3.33 times that of rural residents—slightly above the difference in the early 1980s (RITSSB 1995).

The urban-rural income disparity can also be seen from the changing consumption levels of the urban and rural populations and from the differences in their patterns of consumption (see Table 4.2). From 1985 to 1990, average annual consumption expenditures for urban residents increased from 673.20 yuan to 1,278.89 yuan, while for rural residents it rose from 317.42 yuan to 444.89 yuan. Consumption expenditures for urban residents were 2.12 times those of rural residents in 1985; by 1990 they were 2.19 times, with the six-year average being 2.23 times. Over the period 1985-90, the average annual increase in consumption expenditures was 2.8 percent for urban residents and 2.85 percent for rural residents (Lin 1994).

Consumption is usually understood to be a function of one's income. The propensity to consume can be viewed as either an average or marginal concept: the average propensity to consume is the ratio of total consumption to total income, while the marginal propensity to consume is the ratio of an incremental increase in consumption to an incremental increase in income.

The average propensity to consume for urban residents in China is higher than that for rural residents (see Table 4.2). From 1985 to 1990, the average propensity to consume for urban residents declined from 0.9823 to 0.9219, with the six-year average being 0.9603. For the same period, the average propensity to consume for rural residents first rose and then declined; from 1985 to 1989, it increased from 0.7983 to 0.8900 and fell in 1990 to 0.8518. During this period, the levels of income for both urban and rural residents were relatively low and most income was spent on consumption. In addition to consumption expenses, part of the income of rural residents had to be used to expand self-production, resulting in a lower propensity to consume than urban residents (Lin 1994).

The marginal propensity to consume for urban residents is generally lower than that for rural residents (see Table 4.2). The average marginal propensity to consume over the 1985-1990 period for urban residents was 0.8629, meaning that for every unit increase in income, they spent 86 percent on consumption. For rural residents, the corresponding figure was 0.9256 (Lin 1994).

Table 4.2 Average Consumption Expenditures and the Propensity to Consume for China's Urban and Rural Residents, 1985-1990

Year	Average Consumption Expenditures (yuan)		Average Propensity to Consume		Marginal Propensity to Consume	
	Urban Residents	Rural Residents	Urban over Rural	Urban Residents	Rural Residents	Urban Residents
1985	673.20	317.42	2.12	0.9823	0.7983	n.a.
1986	798.96	356.95	2.24	0.9651	0.8423	0.8822
1987	884.40	298.29	2.22	0.9655	0.8611	0.3704
1988	1103.98	476.66	2.32	0.9863	0.8747	1.0795
1989	1210.95	537.37	2.26	0.9608	0.8900	0.7570
1990	1278.89	584.63	2.19	0.9219	0.8518	0.5367
1985-90 average	991.73	444.89	2.23	0.9603	0.8565	0.8629
						0.9256

Source: Lin (1994).

The income gap between the urban and the rural populations can also be examined in terms of the gap in the savings between the two groups. According to the State Statistical Bureau, as of the end of June 1992, total savings for all residents (urban and rural) was 1,044.1 billion yuan. The average for all residents (urban and rural) was 550 yuan; while the average for urban residents was 1,500 yuan, and the average for rural residents only 155 yuan, about one-fifth of the average for urban residents. From the end of February 1991 to the end of June 1992, the savings of urban residents increased by 42 percent, while those of rural residents increased by 37 percent (SSB 1994).

Since the beginning of the reform process over ten years ago, China's urban residents have witnessed a general increase of income. The average annual increase of total payroll outlays over the period 1978-92 was 7.4 percent. Nevertheless, there still exist great differences across industries and enterprises of different types of ownership.

Within the industry sector, employee wage income varies from one industrial sector to another. For example, in 1991 in the machinery industry, the average annual salary was 2,549 yuan. Letting average wage income in the machinery industry equal 1.0, wage income was 0.89 in the agricultural industry, 1.10 in the transportation equipment manufacturing industry, and 3.79 in the passenger car manufacturing industry.

Among business enterprises of different types of ownership, the average annual wage income of workers in "three-capital" business enterprises (i.e., business enterprises with foreign participation such as those funded exclusively by foreign capital, Chinese-foreign joint ventures, or cooperative enterprises consisting of Chinese and foreign partners) is higher than that in state-owned enterprises while the wage income of workers in state-owned enterprises is higher than that in collectively-owned enterprises. In the machinery industry, for instance, average annual salaries were 2 times higher in three-capital enterprises than those in state-owned enterprises, while only 0.9 times those in collectively-owned enterprises. Over the period 1978-92, salaries in three-capital enterprises boasted the highest average annual increase of 17 percent, while those in state-owned enterprises increased 11 percent and those in collectively-owned enterprises increased 13 percent.

Within the state-owned sector, the difference in employee salaries is also widening. Most state-owned enterprises have linked employee salaries to the economic performance of the enterprise, contributing to an increasingly wider difference in employee incomes across enterprises. For example, among the 137 large and medium-sized state-owned industrial enterprises in Shanghai Shi in 1986, the highest enterprise-wide average annual salary was 1,944 yuan, while the lowest was 1,307 yuan (about 55 percent of the highest

enterprise-wide average); in 1992, the highest average annual salary was 8,893 yuan, while the lowest was 2,485 yuan (about 28 percent of the highest). In the city of Jinan, the highest enterprise-wide average annual salary in 1993 was 7,500 yuan, while the lowest was about 1,500 yuan (about 20 percent of the highest).

Reasons for the Gaps in Urban and Rural Residents' Incomes

There are many factors which contribute to differences in income distribution between urban and rural residents: (1) the dual economic structure (i.e., agricultural-based versus industrial-based); (2) financial burdens placed on the farmers; and (3) increased state benefits and undeclared income received by urban residents.

Dual Structure of the Economy. The dual structure of the Chinese economy is the most important cause of the urban-rural income differences. A measure of the degree of dual economic structure in a developing country is the dual structure index, defined as the ratio of non-agricultural productivity to agricultural productivity.

From the beginning of reform to 1985, the central government reduced the quotas of state levies and raised considerably the prices of some agricultural and sideline² products, which led to an increase in rural residents' income. Meanwhile, business enterprises developed in rural areas and drove up agricultural productivity. The dual structure index tended to decrease, and the income gap between urban and rural areas narrowed. Since 1985, economic reforms have been implemented in the urban areas, providing an impetus for the rapid development of industry and other non-agricultural activities and the rise in urban productivity. On the other hand, the comparative benefits of agriculture have been on the decline, as the marginal production capacity of agricultural products has dropped and agricultural productivity growth has moderated to a slower pace than in the urban areas, resulting in a rise in the dual structure index.

The price scissors, or state-set price differentials between industrial and agricultural products, are another important reason for the urban-rural income gap.³ They are closely connected with the fact that since 1949—under the state economic-planning system—economic activities have been manipulated through administrative means. Price scissors highlight the inequity of the exchange between urban industrial products and agricultural products. Because of the price scissors, rural areas have to provide a substantial amount of capital each year to the cities. It has been calculated that during the past 40 years, China's agricultural sector has provided the industry sector with 1,258 billion yuan. After deducting government aid to

agriculture and the balance of government agricultural income, the agricultural sector has provided the industry sector with a net amount of accumulated capital totaling 1,063.6 billion yuan (RITSSB 1995).

The main feature of the price scissors between industrial and agricultural products is the degree to which prices of agricultural products fall below their free-market values. From 1978 to 1992, the difference between the prices of agricultural products and their free-market values at first experienced a reduction and then an increase. From 1978 to 1987, the difference between list (state-established) prices and free-market prices fell from 35.4 percent to 16.7 percent, but then increased gradually from 1988 to 1993 to 36 percent. As a part of the dual structure, price scissors are an important factor conditioning the urban-rural income gap (RITSSB 1995).

Financial Burdens. Financial burdens have been placed on farmers by the Chinese legal and administrative systems. In the legal system, according to The Agricultural Law of the People's Republic of China (promulgated and implemented on July 2, 1991) and the State Council's Regulations on Fees and Labor Provided by Farmers (promulgated and implemented on December 1, 1991), farmers' duties include taxes, village collective reserve and township coordination fees, rural volunteer and accumulation labor contributions, quotas for agricultural products, and other fees. These legal duties contain many unreasonable elements. For instance, the scope of the agricultural tax is "the land used in growing food crops," and the criterion for the levy is "a certain percentage of the ordinary annual yield of food crops." Such a policy was formulated in reference to rural conditions in the 1950s and is no longer suitable for the current development of the rural economy and the changing economic structure. Following such a standard, farmers engaged exclusively in farming in traditional grain-producing areas have to pay more agricultural tax than those in areas with the benefits of relatively well-developed business enterprises and tertiary industries (Liu 1993).

Moreover, there are also unreasonable elements in the quotas for agricultural products. In the mid-1980s, the government changed the compulsory purchase system into a contract purchase system for purchasing agricultural products, which represented a step forward in the economic reform in the rural areas. In reality, however, the prices set by purchase contracts do not reflect the free-market value of agricultural products. Similarly, purchase contracts for agricultural products are unilaterally binding for farmers, while the government can breach contracts at will. In times of a bumper harvest, the government can "refuse to purchase;" but in times of poor harvest, the government can "collect all." To make up for

price-related losses suffered by the farmers in selling agricultural products to the state, the government links the sale of chemical fertilizers, pesticides and herbicides, diesel fuel, and other agricultural supplies to state-regulated prices and the amount of agricultural products purchased. However, business enterprises engaged in producing and selling agricultural supplies are economically independent entities, which are responsible for their own profits and losses, and if the state cannot compensate them for their losses in selling products at state-regulated prices, such business enterprises will not choose to do business at a loss. Consequently, the state compensation policies cannot be fully implemented (Liu 1993).

There also exist unreasonable elements in the village reserve and township coordination fees. In many places, the village reserve and township coordination fees are misappropriated and misused. Wages, bonuses, and other expenses of the large numbers of non-local township employees are also allocated from the township coordination fees, constituting another kind of unreasonable burden. It is a universal practice to "substitute labor with money," and in most places the 15-30 work-day limit in requesting donated labor from a farmer is exceeded (Liu 1993).

The administrative burdens placed on the farmers are less explicit, but more severe. "First tax light, second tax heavy, third and fourth become endless holes" is a vivid description given by the farmers of the kinds of burdens that they face. The Administrative Office of the Central Committee of the Communist Party and the Administrative Office of State Council have issued the Notice on Review and Recommendations in Regard to Duties and Fees Imposed on Farmers, which makes the following modifications on the duties and fees levied on farmers: 37 items that have been derived from the documents of the central government and other government agencies be abolished; 2 items be postponed to take effect; 17 items be revised; 14 items of forced collection, levy, and willfully-raised fees be put right; 29 items be continued; 43 items which extort money, materials, and labor from farmers be suspended; and 10 wrong practices related to fee collection and fee management be corrected. Apart from those which remain in effect, the total number of items comes up to 121, not including numerous administrative fees. Such a multitude of burdens weigh heavily on farmers.

State Benefits. Benefits provided by the state also account for the increased gap between urban and rural incomes. For instance, in 1991, the average social security payment for urban residents was 413 yuan (not including in-kind and other allowances), while the average for rural residents was only 14 yuan (including aid, grant, and collective welfare income, etc.); thus the social security payments to urban residents were 30 times those made to rural residents, on average.

Most urban residents enjoy government-sponsored medical care; the average annual medical expense for each urban employee was 180 yuan in 1992. Most rural areas do not have adequate medical service and suffer a severe shortage of medical personnel. At the end of 1991, one-third of the rural townships did not have a hospital, and 84,000 villages (about 11.5 percent of all villages) did not have a clinic. In 1992, for every thousand of the rural population, there were only 1.6 hospital beds, whereas for every thousand of the urban population, there were 4.1 hospital beds. For every thousand of the rural population in 1992, there were only 0.98 doctors, 1.8 times fewer than in the urban areas; compared with the figures for 1965, the gap has widened. The infant mortality rate (infants who die before reaching a year of age, per thousand live births) in 1992 was 23.0 for rural areas and 14.5 for urban areas, while the general mortality rate (deaths per thousand population) was 7.1 for rural areas and 5.5 for urban areas (SSB 1994).

Urban employees also receive housing subsidies; in 1992, their rent made up only 0.9 percent of their living expenses. In rural areas, houses have to be built by the farmers themselves, and building expenses make up 10 percent of their living expenses. A large proportion of farmers have built their houses with loans. Although the average living space per person has reached 18.9 square meters, 35 percent of rural houses are made of adobe and thatch.

Great differences between urban and rural areas also exist with regard to the availability of transportation and telecommunication services. In 1992, 10 percent of the rural townships did not have public roads, and 26 percent did not have a post office; 4.1 percent of the rural villages did not have postal service; and 3 percent of the townships and 56 percent of the villages did not have telephone service. Moreover, the number of telephones in rural areas has been on the decline. In 1980, 63 percent of the villages had telephone service; by 1991, the share had dropped to 43 percent. In addition, there is a severe shortage of modern means of transportation in rural areas. Long-distance public transport vehicles are old-fashioned and crowded, and traffic accidents occur frequently. In 1991, there were 177,000 rural traffic accidents in which over 41,000 people were killed, making up 77 percent of the total number of people killed in traffic accidents nationwide (SSB 1994).

Most of the funds for education in China are allocated each year to the cities. The rural areas lack education funds, and they have to rely on self-raised funds to keep their schools in operation. The attendance (in-school) rate for school-age children in urban areas is 99 percent, whereas in rural areas, it is only about 80 percent. The situation is even worse in the remote

areas, mountainous areas, and nomadic areas, where the attendance rate is only about 50 percent (SSB 1994).

INCOME GAPS AMONG INDIVIDUALS

The Poor

Poverty is the deprivation of the means needed to sustain life, namely the failure by an individual, a family, or a certain community to reach the minimum levels of living conditions set by a society. Poverty can be classified into absolute poverty and relative poverty. Absolute poverty, or subsistence poverty, means that in a certain social production mode and life style, the compensation for an individual's or a family's labor plus other legal income is not enough to satisfy the basic needs of life. Relative poverty refers to the fact that in a society the living standards of some people are lower compared with others.

The poverty standard or poverty line is a quantitative level at which poor persons or families are defined and usually refers to the amount of money required to buy the basic consumption items necessary for subsistence. According to Chinese nutrition experts, the minimum number of calories required for a person to subsist in China is between 1,400 and 2,000 calories per day. In 1985, the amount of money needed, on average, to ensure the supply of the minimum amount of calories for subsistence in China was an annual income of 124.8 yuan per person. The 1985 poverty line for rural residents was an annual income of 150 yuan; for ethnic-minority counties, it was 150 to 200 yuan; and for areas which were used as revolutionary bases by the communists before 1949, it was 200 to 300 yuan.

China has a large population base that is poor. Since the beginning of reform and the opening to the outside world, the number of poor people has decreased considerably, but at present there still are a large number of poor people. From 1978 to 1985, China's population below the poverty line declined from 250 million to 125 million. From 1985 to 1990, the state invested 4 to 5 billion yuan annually and reduced the poor population by 40 million. At present, China still has 80 million poor people, who make up 8.9 percent of the country's rural population and 9.1 percent of the world's poor population; these persons do not have enough food and clothing and are living in absolute poverty (*People's Daily* 1991; Wang 1983).

China's poor are mainly concentrated in the 592 counties that receive substantial government subsidies. Most of these poor counties are located in remote and mountainous regions, deserts, cold and high-altitude areas, loess mountainous regions (yellowish brown loamy formations deposited by the

id), areas frequently inflicted with local epidemics, and reservoir areas arginal areas which have a separate administrative authority). In the East, poor counties are mainly located in the Yimeng Mountains and the southwestern and northeastern Fujian Province; in the Central, they are located in the Nulu'erhu Mountains, the Taihang Mountains, the Luliang Mountains, the Qinling-Daba Mountains, the Dabie Mountains, the Jinggang Mountains, and southern Jiangxi Province; in the West, they are located in the Dingxi drought area, Xihaigu, northern Shaanxi Province, Tibet Autonomous Region, southeastern Yunnan Province, the Hengduan Mountains, the Ninety Thousand Mountains, the Wumeng Mountains, and the northwest of Guangxi Autonomous Region. The poor counties cover most of the provinces in the Central and the West.

Poor areas are characterized by a backward infrastructure and poor living conditions: 1,700 townships (or 3.5 percent of all townships) and 10,000 villages (or 21.0 percent of all villages) do not have access to public roads; 1,400 townships (or 3 percent) do not have electricity; 560 townships (or 1.2 percent) do not have postal service. Over 80 million people suffer from a chronic shortage of drinking water. In the reservoir areas, 95 million live under rather poor conditions and 1.04 million people have less than an average of 0.5 mu (or 0.0822 acres) of farmland. In addition, 5 million people live under extremely harsh conditions and will have to be transferred elsewhere to get out poverty.

Medical facilities are inadequate in the poor areas: 2,123 townships (or 4.1 percent of the country's total) do not have hospitals. According to a survey of medical facilities in 300 poor counties that was conducted by the Ministry of Health in 1980, the maternal mortality rate (number of female deaths that occur during childbirth, per thousand births) was 202, more than two times the country's average of 95 per thousand births, and more than ten times the rate for either Beijing Shi or Shanghai Shi. In China's poor southwestern mountainous area, only 10 to 30 percent of the children receive vaccinations for measles, pertussis, diphtheria, and infantile paralysis.

The level of education is low in poor areas. In 1991, the Chinese Youth Political Academy organized a survey of elementary schools in 113 poor counties in 22 provinces. The survey revealed that in 1990 there was a shortage of 36,160 teachers (based on the assumption that twenty students require one teacher) and a total of 800,000 students were without teachers. In the counties surveyed, there were 5.1 million school-age children in 1990, but only about 90 percent (or 4.56 million) were in school and poverty prevented the remaining 10 percent from attending school (BYJ 1994).

The Rich

In the early 1990s, a high-income class began to emerge in China's urban population. While this class does not make up a significant share of the total urban population, it does possess a significant amount of wealth. According to a conservative calculation, at present this high-income class consists of about 5 million people nationwide, making up more than 3 percent of China's urban employees. Moreover, these persons appear to be concentrated in non-production activities. The income of this high-income class is at least 10 times higher, if not more, than the lowest-income class (wage earners) and constitutes a new phenomenon not seen since the founding of the People's Republic.

There are currently a small number of millionaires and a larger number of persons with concentrated wealth in China, but there is no exact count and estimates of their numbers vary greatly. According to 1990 statistics from the State Bureau of Industry and Commerce, there were 486 private business enterprises with assets over one million yuan (i.e., millionaires). Third quarter 1991 statistics showed that there were 723 private business enterprises with assets over one million yuan. The Development Research Center of the State Council reported that as of March 1993 there were over 5,000 persons with assets over one million yuan, including more than 200 persons with assets over ten million yuan. However, according to some long-time researchers of the private Chinese economy, the above numbers represent very conservative estimates of the actual number of rich persons in China.

As of the end of 1992, Guangdong Province had over 250 private business enterprises with registered capital of between one million yuan and ten million yuan. In fact, in Guangzhou City alone, there were about 200 private business owners with assets over one million yuan in 1990. In 1992, there were 1,100 private business owners in Haikou City with assets over 100 million yuan. In Chengmai County, Hainan Province, there were over 100 ten-million-yuan magnates. Among the independent contractors who were engaged in construction projects in Caixi Township, Shanghang County, Fujian Province, there were about 100 families with assets of over one million yuan, including five families with assets of over ten million yuan. In the coastal provinces, there were 30 to 40 families with total savings of over 100 million yuan.

Nationwide, it is estimated that over 200,000 private business enterprises operated under the name of state-owned or collective establishments. In 1990, the total registered capital of private business enterprises nationwide

was close to ten billion yuan, with each enterprise averaging over one million yuan.

According to the State Statistical Bureau, at the end of 1992, private entrepreneurs in both urban and rural areas made up only 3 percent of the country's total population, but possessed savings of over 320 billion yuan, or 28 percent of total savings nationwide. Individual entrepreneurs and private business owners held 60.2 percent of the national total of cash on hand in 1992. There were 11.2 million individuals and private entrepreneurs in 1993 who possessed a total savings of 413 billion yuan, with each person averaging 37,000 yuan, which was 2.3 times higher than the average urban households' savings nationwide and 10 times higher than the average savings of all urban residents (estimated at over 3,300 yuan). Of these individuals and private entrepreneurs, some had savings over 100,000 yuan, constituting an even more striking difference between the rich and the ordinary urban residents. Apart from monetary and financial assets, quite a number of very high income people possess private passenger cars and luxurious vacation homes, in stark contrast to most other urban residents.

Who are these new rich? According to the Sampling Survey of Personal Income Distribution Among Urban Residents and related studies conducted by the Human Resource Institute of the State Planning Commission, the high income class is mainly composed of the following types of persons: upstarts in stock, futures, and real estate trade; high income private business owners and individual entrepreneurs; movie, TV, sports, and other entertainment stars; managers of new companies; contractors and operators; Chinese managers in some three-capital business enterprises; professionals for whom the demand is much greater than the supply; scientists and researchers who have contract research projects; taxi drivers; bank employees; and retired persons who have rejoined the workforce. Of these persons, the ones with the highest income are: private business owners and individual entrepreneurs; actors and actresses and their agents; Chinese managers in joint ventures; contractors of rural business enterprises; and all kinds of agents. High-income individuals are mainly concentrated in the coastal areas of the Southeast and in the big cities.

Increasing Income Gaps Between the Rich and the Poor

In the mid-1950s, the noted economist Simon Kuznets hypothesized that "in the early phases of industrialization in the underdeveloped countries income inequalities will tend to be wider before the leveling forces become strong enough first to stabilize and then reduce income inequalities" (Kuznets 1955: 24). Subsequent empirical studies have tended to confirm this conjecture.

Based on data from the World Bank's *World Development Report 1992*, in low-income countries (those with a gross national product per capita of \$610 or less in 1990) for which data were available, the average difference in the percentage share of household income in the lowest income class (the lowest quintile) and the highest income class (the highest quintile) was 5.8 times; in medium-income countries (those with a gross national product per capita of more than \$610 but less than \$7,620 in 1990) the average difference was 10 times, with Brazil and Botswana reaching 26 times and 30 times, respectively; and in high-income countries (those with a gross national product per capita of \$7,620 or more in 1990) the average difference was much smaller, only 6.8 times. But even within the group of high-income countries, there was wide variation: in Japan and Sweden, the difference in the percentage share of households in the lowest and the highest income classes was only over 4 times; in the United Kingdom, France, and Italy, it was about 6 times; while in Australia, the United States, New Zealand, Singapore, and Switzerland, it was about 9 times.

The difference in income between the highest and lowest quintiles (i.e., the top-20 percent and the bottom-20 percent) in China's urban areas increased from 1.7 times in 1981 to 2.5 times in 1990; while the difference for rural areas increased from 2.9 times in 1978 to 4.5 times in 1990. The weighted average for urban and rural areas together was about 4 times. Compared with other countries, China's difference between the highest and lowest quintile income groups is not substantial. However, if families with the highest income are compared to those with the lowest income, the difference would be much larger. At present, there are about five-million families in China with an annual income above 10,000 yuan; whereas for the lowest-income families, the average monthly living expenditure income per person for urban residents is below 35 yuan and the average annual net income per person for rural residents is below 150 yuan.

The number of poor people in urban areas is on the rise. For some families, their expenditures are greater than their income. Among the urban poor, most are employees in state-owned enterprises or collectively-owned enterprises. Because of poor economic performance, production at some of these enterprises has been suspended or reduced, resulting in diminished employee income. Also, some retired workers can barely make ends meet with their pensions, especially in the face of rising prices. According to official statistics for the first half of 1994, the number of urban residents whose average monthly income was below 103 yuan had reached 20 million nationwide; these persons belonged to the lowest income group.

According to a sample survey conducted by the Henan Provincial government from January to June of 1993, the average annual living

enditure income for urban residents was 878.64 yuan; for the low-income families (which made up 10 percent of the total surveyed), the average annual living expenditure income per person was only 423.99 yuan (with a monthly average income of 70 yuan), not enough to cover the expenses. Of the low income group, 75 percent were employees of state-owned enterprises who were in a state of long-term suspension, partially closed, or experiencing poor economic performance.

Up to this point, I have concentrated on the income gap between the rich and the poor in the urban areas. Now let us look at such gap among the rural population. During the People's Commune period, egalitarianism was practiced in China's rural areas; the Gini coefficient (a measure of inequality which one represents complete inequality and zero perfect equality) for rural income was below 0.2, and the distribution was fairly equal. After 1978, when reforms and the family responsibility system were implemented, rural enterprises mushroomed, and the difference in income distribution among farmers began to grow. In 1990, the Gini coefficient for farmer income went up to 0.31 and then again increased to 0.33 in 1993 (SSB 1994).

While the general income level for rural residents has risen, differences across various income groups have also been enlarged because of growing income and rising inflation. A comparison of data for 1985 and 1990 reveals that the two-lowest income groups—containing those with incomes below 500 yuan—have declined substantially in size: those with income below 200 yuan declined from 12.2 percent of all rural residents in 1985 to 2.0 percent in 1990, while the subgroup with income between 200 and 500 yuan declined from 65.5 percent to 32.9 percent (see Table 4.3). In contrast, the two-highest income groups—containing those with incomes above 500 yuan—have grown considerably over the same period of time: those with income between 200 and 500 yuan went up from 20.0 percent of all rural residents in 1985 to 47.3 percent in 1990, and those with income above 500 yuan went up from 2.3 percent to 17.8 percent of all rural residents. Relative to the lowest income group, average income in the other groups was, in ascending income order, 2.1, 3.8, and 7.6 times greater in 1985 and 2.7, 4.9, and 9.3 times greater in 1990, reflecting an increase across all groups; however, the average income of the lowest income group declined relative to the other groups (Lin 1994).

The income disparities are even more striking between those rural residents who derive their income from agricultural and non-agricultural activities. According to a 1990 nationwide rural resident survey, the average income of farmers engaged exclusively in farming was 1,097 yuan, while the average net income of those whose non-agricultural income constituted

Table 4.3 Average Income Levels of China's Rural Residents, 1985 and 1990

Group Income Level	1985			1990		
	Average Income Level	Percentage of all Rural Residents	Income Index (below 200 yuan = 1)	Average Income Level	Percentage of All Rural Residents	Income Index (below 200 yuan = 1)
All Group Average	397.60	100.0	..	686.31	100.0	..
Below 200 yuan	162.70	12.2	1.00	145.84	2.0	1.00
200-500 yuan	334.74	65.5	2.06	386.39	32.9	2.65
500-1000 yuan	616.88	20.0	3.80	709.30	47.3	4.86
Above 1000 yuan	1237.61	2.3	7.61	1354.98	17.8	9.29

Source: Lin (1994).

over 80 percent of their total income was 2,293 yuan (2.1 times that of those exclusively engaged in farming). Such a difference is greater than the difference of 1.6 times between the highest-paying profession and the lowest-paying profession in urban areas (Lin 1994).

OWARDS A MORE EQUITABLE INCOME DISTRIBUTION NDER A DEMOCRATIC FRAMEWORK

As China's market economy develops further, differences in income distribution will become a more evident feature. Meanwhile, government and market distribution mechanisms will exist side by side and continue to function together. Government distribution mechanisms mainly consist of financial policies and income distribution policies, which regulate the distribution and redistribution of national income in order to achieve social justice. Income received from the market economy will be necessarily distributed through the market mechanism. However, the objective of applying market distribution mechanisms is to improve economic efficiency instead of ensuring social justice. Market-oriented distribution mechanisms will give rise to greater differences or even polarization in income distribution. Therefore, the government distribution mechanism should be brought under a democratic framework, where the rights and interests of social groups are protected. Such a governance system would be able to make up for the inadequacies of the market mechanisms so that social justice will be maintained to a certain degree. Income distribution in the modern market economy should be based on the market, but regulated by government mechanisms. As for the increasing differences in income distribution between regions, urban and rural areas, and individuals, they can only be adjusted and reduced through changes in government policies and the economic system in the course of further development of the market economy.

To get out of the "low-level development trap," underdeveloped areas will have to be provided with substantial economic aid and be engaged in economic relations with the outside world. The key to opening up these areas internally is to attract investment through multiple channels, raise considerably per capita investment, and use effectively available funds. During the transition to a market economy, the central government should strengthen its ability to regulate the economy on a macro level, based upon private property rights rather than the socialist notion of public ownership, and utilize its financial resources to fully regulate regional interests to smooth out and eventually reduce regional differences. The central government should attempt to balance development nationwide and try to maintain

political stability by investing available resources in the underdeveloped areas. Such investment should concentrate on infrastructure (such as transportation and communication systems) and on reforms of the economic system to cultivate non-state-owned business enterprises and promote economic activities on a micro-level so as to lay the groundwork for development.

Meanwhile, the central government should encourage the establishment of a market economy with fair competition and suspend economic privileges which hinder reduction of regional differences, especially the preferential policies enjoyed by the high-income areas. The government should support and help the underdeveloped areas in reducing the number of the poor. Helping the poor should start with aid and then evolve into developmental support so as to build up the "blood-making" capacity of the underdeveloped areas. The government should support and help the minority nationality areas to speed up their economic development and enable them to benefit from the fair exchange and utilization of their resources.

The underdeveloped areas should make full use of mutual and supplementary economic relationships that have been forged on the basis of regional differences, use local labor resources to attract technology and funds from developed areas, participate actively in domestic and international trade, expand the capacity and magnitude of the market, and promote the development of the local economy. At the same time, another important task for the underdeveloped areas is to change the function of government agencies and speed up reform of government institutions. Institutional reform is of great significance to increasing efficiency in government agencies and strengthening their public service function. Streamlining government institutions is a necessary step in reducing the financial burden on individuals and building up a market economy. In terms of structural reform, the underdeveloped areas should learn from the developed areas to vigorously promote growth of non-state-owned business enterprises and to privatize the state-owned enterprises.

CONCLUSION

The urban-rural income gap has become one of the bottlenecks for China's economic development. It is a potential source of social unrest, too. The root cause of the urban-rural differences is the dual economic structure, the determinants of which cannot be eliminated in the short run. With further development of the market economy, cities will continue to maintain a higher rate of growth and a more rapid pace of structural adjustment. Because the outstanding problems in rural areas (such as slow growth of agricultural

roduction, constraints on rural business enterprises, and relatively low income of farmers) cannot be solved in a short period of time, it is likely that the urban-rural gap will continue to expand.

In China, the expansion of the differences between urban and rural incomes is, to a great extent, related to the system which gives preference to the cities. Therefore, the reduction of urban-rural differences should begin with adjustment of those interests. Price scissors and inadequate investment in agriculture are important factors which prevent development of agriculture and increases in farmer income. The government should gradually reduce the inequality embodied in these government policies and restore a balanced relationship between urban and rural areas by utilizing the market mechanism. In addition, price and tax reform should be implemented to strengthen the position of agriculture in the marketplace.

The welfare system and the resident registration system are two other important barriers standing between urban and rural areas. The welfare system is characterized by government-ensured supply and ration as well as other benefits. Once an individual obtains access to these benefits, a lifetime supply is guaranteed. Reform of the welfare system must include reform of the housing, medical care, and social security systems.

It will also be important to set up equal-opportunity market mechanisms to promote mobility of labor between urban and rural areas. The existence of "farmer (or peasant) workers" (*mingong*), that is, farmers with rural residential registration working in urban areas, is a reflection of the inequality in labor force exchange between urban and rural areas. Cities accept and benefit from cheap labor from rural areas, but do not provide fair compensation for such labor. Because of their different "identities" established under the residential registration system, farmers and urban workers doing the same job do not receive the same pay. Farmer-workers are usually engaged in undesirable jobs and have to put up with poor living conditions. In addition, farmer-workers have to pay all kinds of fees collected by relevant agencies in cities. It is difficult for farmers to move to and live in cities; there exist immense constraints on the free flow of labor between urban and rural areas.

Regulation of income differences between the rich and the poor should be focused on the problems of unlawful income, poverty, and inflation. The government should not set income caps through administrative means. As for high income derived from lawful operation of businesses and honest labor, the law should provide protection. The income differences caused by this kind of high income should be effectively regulated through taxation. Those who take advantage of the incompleteness of the legal system, the inadequacy of reform policy, and the loop-holes in the regulating system to

obtain their income by misappropriating state resources or by engaging in unlawful profiteering activities such as embezzlement, bribery, the manufacture and sale of poor-quality products, smuggling and the sale of smuggled goods, deceptive business practices, monopoly of the marketplace, tax evasion, and so on, should be dealt with sternly by legal means.

The government should formulate anti-poverty and social security policies to provide help to those in the lowest income classes (i.e., farmers in poor rural areas and urban workers in state-owned establishments with poor economic performance). The government should also try to improve the social security, insurance, and financial aid systems to help satisfy the basic needs of life for those in these lowest income classes.

Notes

1. This paper originates from a research project done at the China Strategic Institute. A number of the Institute's research associates inside China have commented on and contributed to this project at various stages, though the author remains responsible for any errors and shortcomings in this paper.
2. Sideline production is defined by China's State Statistical Bureau as production that includes the collection of wild plants, hunting of wild animals and fowls, and handicraft and other industries concurrently run by farm households.
3. Price scissors (or the price disparity between industrial and agricultural products) are the result of the state policy of suppressing the prices of agricultural products in order to shift resources to the industrial sector.
4. Under the household responsibility system, land was reallocated and cultivated by individual households under contract and non-agricultural industries, including cottage industries, were promoted and peasants were allowed to keep and use sideline production as well as agricultural production under contract.

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Table 4.1 **Average Per Capita Disposable Income for China's
Urban and Rural Residents, 1980-1993**
(yuan/person)

Year	Urban Residents	Rural Residents	Ratio: Urban over Rural
1980	620.19	191.33	3.24
1981	681.71	223.44	3.05
1982	721.54	270.11	2.67
1983	770.36	309.77	2.49
1984	870.31	355.33	2.45
1985	967.20	397.60	2.43
1986	1143.49	423.76	2.70
1987	1268.66	462.55	2.74
1988	1477.70	544.94	2.71
1989	1704.68	601.51	2.83
1990	1921.96	686.31	2.80
1991	2148.52	708.55	3.03
1992	2484.24	783.99	3.17
1993	3070.90	921.40	3.33

Source: RITSSB (1995).

29. HOUSING REFORM

China's Housing Sector Reforms

General Information: Housing

China's Housing Sector Reforms

China's senior leaders since last fall have cited residential housing construction as a "new growth point" for the economy. Premier Zhu Rongji in a televised press conference last month highlighted the sector as one of five key areas of economic reform during the next three years. Chinese officials have set ambitious targets for development of the sector:

- China's construction minister in January stated China would build one billion square meters of new housing in urban areas during the next three years—implying a roughly 20-percent increase over the annual rate of construction since 1992.
- Central bank governor Dai Xianglong announced in March that state banks would be allowed to earmark 15 percent of new lending for residential construction and the central bank has raised the ceiling on housing loans from 10 billion last year to 100 billion yuan this year, according to official Chinese press.

Chinese officials have estimated that if Beijing meets its targets, the housing sector could contribute 0.7 percentage points to GDP growth this year, according to official Chinese press. The housing market during the last year, however, has not been a major source of growth. Vacant housing space rose 25 percent to over 70 million square meters in 1997, according to Chinese statistics cited in press reports. One of the major obstacles to development is that many state enterprise provide apartments to workers for free or nominal fees, which weakens incentives to buy. Even when workers can buy apartments from enterprises, there often are provisos to the sale that hamper opportunities for resale.

Premier Zhu during his press conference last month said that to stimulate the housing market Beijing will issue a new policy in the second half of 1998 which will monetize housing benefits, commercialize housing, and stop allocation of housing as welfare.

- Chinese government agencies are working on a national housing reform plan that will be issued before June, according to recent Chinese press reports. According to the director of the State Council's Housing Reform Office, new housing will be sold to workers instead of being leased. Under the plan workers will receive housing subsidies in addition to wages that may be used only for buying or renting housing.
- A major constraint may be financing. China's large state banks have issued new regulations governing mortgages under which homebuyers can lend up to 70 percent of the value of the residence at maximum term of 20 years, but this may not be enough to substantially raise incentives to buy. A flat of 60 square meters in Beijing sells for 15 to 21 times the average household's income, according to official Chinese press.

General Information

Housing

For the first time since the Communists banned home ownership in 1949, Chinese citizens are once again able to purchase their own homes. Private home ownership is now replacing the previous housing system whereby the government, through subsidized rentals, provided housing for Chinese citizens. The new possibility for home ownership is creating extensive opportunities for both the Chinese citizens purchasing the homes and the many industries related to "home ownership".

The state supported and subsidized communist system has allowed many Chinese citizens to accumulate significant amounts of savings. As rents on state owned housing have increased dramatically, in some cases as much as doubling over the past four years, many residents are redeploying their savings for use in purchasing a home. These new purchases have created increased activity in the residential construction and home financing industries.

One interesting note is that most Chinese housing, especially new construction, is sold as a shell. This shell is normally a cinder block or concrete frame that is devoid of flooring, doors, and often even basic fixtures. It is the new owner's responsibility to complete the home. This is creating strong demand for "finishers". Many new interior design companies and home furnishing businesses are being established throughout China.

Housing Programs

The Chinese government is encouraging the move to private housing and has established a new program called "The Provident Fund". This program requires that each providence set up a fund that collects 5 percent of each worker's pay plus an equally matched amount from their employer. These funds then become available for lending in the form of mortgage loans and/or low-cost construction loans.

It should be noted that the government benefits extensively from the privatization of the housing market. First, through private ownership the huge government rental subsidies are eliminated. Second, many of the properties that are being purchased were previously owned by the government. As a result, these sales transactions are converting the properties into cash for the government.

The Problems and Transformation of the Urban Housing System in China

Urban housing crisis

Before urban housing reform was initiated nationwide in the late 1980s and early 1990s, housing problems had been ranked as the most severe and explosive social problem by both urban dwellers and officials.

- **Housing shortages:** Per capita living space was estimated at 4.5 m² (4.5 square meters or 48.5 sq. ft.) when the People's Republic of China was founded in 1949. It soon dropped precipitously, and it was not until three decades later that China returned to that level. In 1986 the national average increased to 6.1 m² (65.7 sq. ft.). In the early 1990s, 4.9 million households were officially categorized as "families with housing difficulties", including *homeless families* (living in spaces that were offices, classrooms, workshops or warehouses during the daytime) and *severely crowded households* (several generations or families living under the same roof). In 1990, the vacancy rate in Beijing was 0% — the lowest among 52 cities surveyed worldwide by the United Nations.

- **Inequality:** China's First General Survey of Urban Housing of 1986 revealed that over half (56.8%) of city dwellers had living space below the national average (6.1 m² or 65.7 sq. ft. per capita). On the lower end of the distribution, 7.7% were homeless and 18% lived in an average space of less than 4 m² (43 sq. ft.) per capita; at the higher end, one-fifths (21%) occupied dwellings with 8 m² (86 sq. ft.) per capita or more.

- **Poor quality:** Many urban families were troubled by the poor state of repair of their units. Old and dilapidated housing constituted 300 million m² (3.2 billion sq. ft. or 13.9 of the total floor space of urban housing) in 1991. Of this, 31.4 million m² (338 million sq. ft.) were rated as *dangerous housing* — that is, it could easily be leveled by a storm or a heavy rain. Moreover, most urban homes lacked sufficient facilities. In 1986, urban homes equipped with gas, bathtubs and heating were only 12%, 8% and 24% of the stock, respectively. Homes that lacked indoor toilets, kitchens and running water constituted 57%, 30% and 18% of the stock, respectively.

Roots of the urban housing crisis

- **Explosive growth of urban population.** Urban population growth stems from the huge population base compounded by Chairman Mao's policy "the more people, the stronger the power will be". Planned and unplanned rural-urban migration also contributed to urban population growth. As a result, housing demand in urban areas has been increasing faster than ever before in China and faster than in any other country.

- **Biased state capital investment policies.** Housing is categorized as *nonproductive* capital construction investment and given extremely low priority compared with *productive* investment. The housing sector received on average 6% of total capital investment between 1958 and 1978, with a low of 2.6% in 1970. Consequently, there has been a sharply expanding gap between housing production/supply and demand.

- **Land-use policies.** The goal was to transform consumer cities of old China into socialist producer cities. The results were disproportionate concentration of industries in central cities and tremendous shortages of urban land used for housing workers.

- **Failure of the pre-reform public housing system (see below).**

Pre-reform housing system

Public housing constitutes the vast majority of the urban housing stock in China: It was 83% nationwide in 1984, and 97% in Beijing in 1990 — the highest figure in the world. In contrast, rural housing is always privately owned and often self-built. Three chief elements composed the public housing system prior to reform and still play a role in the reformed system:

- Investment and finance dominated by the state: 91.8% of urban housing investment was financed by state nonproductive capital funds between 1950 and 1985. The majority of capital funds, along with subsidies for operating costs, were distributed to work units (the remaining to local government). The Construction Bank of China administered funds and audited their use. There were no home mortgage markets in China. Because state property (housing, land, etc.) was not allowed to be sold, the state was unable to recoup any of its capital investment in the housing sector.

- Allocation mainly through *work units*: Work units were responsible for maintenance, management and allocation of public housing. The distribution of housing was determined by a scoring system under which employees' official position, seniority and needs were decisive factors. This work-units-oriented allocation system has resulted in the waste of housing resources and housing inequality.

- Return from individuals: The monthly average rent was 0.13 yuan per square meter (\$0.18 per sq. ft) in 1985. Although it was integrated with a low-wage system, rent-to-income ratios ranged from 1-3% nationwide in the late 1980s. The ratio was 6% in Beijing in 1990 — one of the lowest five cities in the world according to the U. N. Typically, rents were not enough to cover even 10% of operating costs of public housing.

Housing system reform

After 9-year experiments in various localities, a comprehensive housing system reform was adopted in January 1988 but was not implemented effectively for four years. Since the late 1991 there has been an upsurge of reform in most Chinese cities. The key reform strategies are "forming a healthy circle comprised of advancing house-building, increasing rent, promoting sales, and recovering funds".

- Broadening of housing construction channels. The state has abandoned its bias against housing investment. Work units and individuals are given preferential treatment and government assistance in constructing housing units for their employees or themselves. In the last several years, work units have become the biggest players in owning and building new residential units in urban areas.

- Establishing the real estate market. Production and transaction of commercial housing by overseas or domestic developers (for *foreign sale* or for *domestic sale*) are now permitted and encouraged. Most recently, while most overseas companies have entered the luxury housing market, the Chinese government has introduced preferential policies for those developing "comfortable" and low-cost housing projects. These policies include a guaranteed 15% profit rate, though it has hardly been less than 30% in the past. (One hundred percent recovery of the initial investment is usually attained in 5-6 years). Currently, new construction and housing rehabilitation by real estate companies is the fastest growing segment of housing production and urban revitalization in China.

- Restructuring rent. The purposes of this reform strategy are to retrieve the public investment gradually and to provide financial incentives for occupants to purchase their public housing. Five models have emerged from the reforming practices: "*more space, more rent*", "*increase rent, issue housing vouchers*", "*match rent increases with wage increases*", "*increasing rent with fewer subsidies*", and "*new housing, new rent*". (Please see Tong and Hays (1996) for more detail).

- Selling public housing. Owner-occupancy in urban China is the lowest in the world, according to the U. N. In 1990, only eight percent of Beijing households owned their homes. The sale of public housing is the starting point and a crucial step. The *market price* has been generally applied to units exceeding state space standards, most of which are new. Many reform efforts of this type of housing sale have been devoted to affordability since the price-to-income ratio was extremely high at the beginning of reform. (The ratio was 14.8 in Beijing — the highest in the world in 1990). Thus, the most popular type of sale of public housing among ordinary people has been the *standard price*, which is applied to units within the state standard for living space. This price usually incorporates depreciation, a discount, work-unit contributions and state subsidies in some forms.

- Establishing the housing finance system. The "public accumulation funds", an effective but compulsory savings model for housing, has been implemented nationwide. Moreover, for those purchasing their units, a mortgage finance system has been developed recently. The buyer can obtain a low-interest mortgage from state banks. The downpayment is typically 30% and the term is 15 years.

Concluding remarks: Chinese housing reform has featured gradualism and decentralization, leading to co-existence of the pre-reform system with the reform initiatives. This approach is called a "dual track system". Although this unique combination will lead to commercialization or greater reliance on market forces, it will be difficult for the Chinese housing sector to accomplish its ambitious goal -- development of 900 million m² (9.7 billion sq. ft.) of residential housing in the 1996-2000 period -- without participation of foreign investors and financial institutions.

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Housing Research
Fannie Mae Foundation
October 7, 1997

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China

The People's Republic of China (China) is the world's most populated country and the second largest energy consumer (after the United States). Production and consumption of coal, its dominant fuel, is the highest in the world. In addition, with international assistance, China is boosting its domestic oil production and adding electric generating capacity to meet energy demand increases associated with rapid economic growth.

COUNTRY OVERVIEW

President: Jiang Zemin (since March 1993; next election 1998)

Premier: Li Peng (since April 1988)

Population (1996E): 1.2 billion

Location/Size: Eastern Asia/9.6 million square kilometers (3.7 million square miles, slightly larger than the United States)

Major Cities: Beijing (capital), Shanghai, Tianjin, Guangzhou, Shenyang, Wuhan, Chengdu

Languages: Mandarin (official), many local dialects

Ethnic Groups: Han Chinese (92%); Zhuang, Uygur, Hui, Yi, Tibetan, Miao, Manchu, Mongol, Buyi, Korean, others (8%)

Religion: Officially atheist; Daoism, Buddhism, Muslim (2-3%); Christian (1%)

Defense (7/95): Army (2.2 million), Navy (260,000), Air Force (470,000)

ECONOMIC OVERVIEW

Currency: Yuan

Exchange Rate (5/97): US\$1 = 8.3 Yuan

Gross Domestic Product (GDP, 1996E): \$750 billion, in 1990 dollars; \$828.3 billion nominal

Real GDP Growth Rate (1996E): 9.7%

Inflation Rate (1996E): 8.4%

Current Account Surplus (1996E): \$9.8 billion

Major Trading Partners: Hong Kong, Japan, United States, Germany, Russia, Italy

Trade Surplus (1996E): \$14.4 billion (\$39.5 billion with the United States)

Exports: \$130.1 billion (\$51.5 billion to U.S.)

Imports: \$115.7 billion (\$12.0 billion from U.S.)

Major Export Products: Textiles, garments, footwear, toys, crude oil

Major Import Products: Rolled steel, motor vehicles, textile machinery, oil products

Monetary Reserves (1996, non-gold): \$105 billion

External Debt (1996): \$116.5 billion

ENERGY OVERVIEW

Energy-Related Ministers: Wang Senhao (Coal Industry); Shi Dazhen (Power Industry); Song Ruixiang (Geology and Mineral Resources); Niu Maosheng (Water Resources)

Proven Oil Reserves (1/1/97): 24 billion barrels

Crude Oil Production Capacity (1996E): 3.1 million barrels per day (MMBD)

Crude Oil Production (1996): 3.1 MMBD

Crude Oil Consumption (1996E): 3.4 MMBD

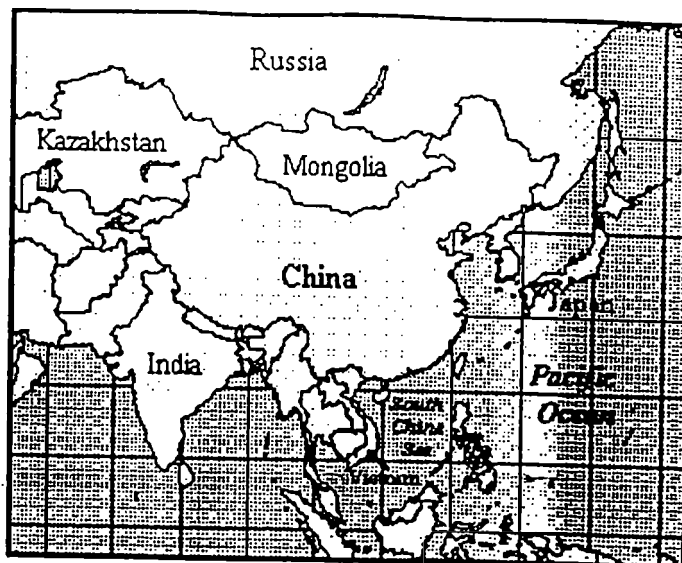
Crude Oil Imports (1996E): 0.3 MMBD

Crude Oil Refining Capacity (1/1/97): 2.9 MMBD

Natural Gas Reserves (1/1/97): 41 trillion cubic feet (Tcf)

Natural Gas Production/Consumption (1996E): 0.7 Tcf

Recoverable Coal Reserves (1996E): 126.2 billion short tons



Coal Production (1995): 1.48 billion short tons

Coal Consumption (1995): 1.46 billion short tons

Net Coal Exports (1995E): 20 million short tons

Electric Generation Capacity (1995): 190 million kilowatts

Electricity Generation (1995): 887 billion kilowatthours

ENVIRONMENT OVERVIEW

Total Energy Consumption (1995): 35.7 Quadrillion Btu

Energy Consumption Per Capita (1995): 29.7 million Btu (vs. 331.8 million Btu in the United States)

Energy-Related Carbon Emissions (1995): 821 million metric tons (13% of world carbon emissions)

Carbon Emissions Per Capita (1995): 0.7 metric tons (vs. 5.42 metric tons in the United States)

Major Environmental Issues: Air pollution and acid rain from burning high-sulfur coal; limited access to potable water due to shortages (particularly in urban areas), pollution from industrial effluents, and absence of sewage treatment; deforestation; loss of agricultural land due to soil erosion and economic development; trade in endangered species.

ENERGY INDUSTRY

Organization: *Coal* - China National Local Coal Mines Development Corp., China Northeast & NEI-Mongolia United Coal Co., numerous local state-owned mines and rural collectives; *Petroleum* - China National Petroleum Corp. (CNPC), China National Offshore Oil Corp. (CNOOC), China National Oil & Gas Exploration & Development Corp. (CNODC), China National Star Petroleum (Star); *Refining* - China National Petrochemical Corp. (SINOPEC); *Oil imports/exports* - China National Chemicals Import and Export Corporation (SINOCHEN), China United Petroleum Corporation (China Oil), China United Petrochemical Corp. (UNIPPEC); *Electric power* - Huaneng Group, Inc., China National Power Industry Corp. (CNPIC), regional electric power corporations, China National Nuclear Industry Corp., China International Water and Electric Corp. (CWE); *Energy Finance* - China National Energy Investment Corp.

Major Producing Oil Fields (1995 Production): Daqing (1.1 MMBD), Shengli (0.6 MMBD), Liaohe (0.3 MMBD)

Major Refineries (1/1/97 Capacity): Fushun (174,000 b/d), Maoming (170,000 b/d), Qihu (160,000 b/d), Gaoqiao (146,000 b/d), Dalian (142,000 b/d), Yanshan (140,000 b/d)

BACKGROUND

By virtue of its large population, rapidly growing economy, and status as the largest remaining communist country, China is an important player on the world's stage. Recent economic growth has exceeded population growth, improving the standard of living for the population as a whole; however, development is progressing disproportionately faster in coastal and urban areas (including several duty-free "special economic zones" in which foreign businesses receive tax, investment, and other incentives) than elsewhere in the country. Large state-owned companies dominate the economy. Many of these operate at a loss, and their reform is now a high priority for China's leadership.

The death of China's retired senior leader Deng Xiaoping in February 1997 has had little impact on China's policies or its economic reform program. Major leadership changes are not anticipated before the next Communist party congress (fall 1997).

China's economic progress is proceeding with significant foreign assistance. Since the late 1970s, China has received a total of \$177 billion in foreign direct investment, and expects to receive \$230-270 billion between 1996 and 2000. China is particularly interested in agriculture, infrastructure, and high-tech projects. China is the largest recipient of World Bank loans -- \$26 billion for 170 projects since 1980 and an additional \$2.5-3.0 billion annually over the next 3 years. Current World Bank funding priorities are inland transportation, power projects, pollution control, and poverty alleviation.

The United States and China are major trading partners, but this relationship is strained by a range of issues (including human rights, nuclear proliferation and arms sales, trade barriers, and intellectual property rights). In May 1997, U.S. President Bill Clinton announced that he would extend China's "most favored nation" trade status for another year. Other concerns include the size of the U.S. trade deficit with China (second highest, after Japan) and allegations over Chinese campaign contributions in the 1996 elections. Recent steps to assist U.S. companies in expanding their export markets in China include the opening of a Department of Commerce commercial center in Shanghai and the posting of an Export-Import Bank loan officer in Beijing.

A positive step in China's international relations was the signing of the Nuclear Test Ban Treaty in 1996. Regional tensions, however, continue to raise concerns. These include ongoing disputes with Taiwan (which China considers a renegade province) and

territorial disputes over potentially hydrocarbon-rich areas of the South China Sea (also claimed by Vietnam, the Philippines, Brunei, Malaysia, and Taiwan) and the East China Sea (also claimed by Japan). World attention is also focused on how well Hong Kong becomes integrated into China beginning on July 1, 1997. In addition, China seeks membership in the World Trade Organization.

The primary role of China's energy industry, as described in the Ninth 5-Year Plan (1996-2000), is to support the country's economic growth. This is to be accomplished by gradually alleviating industry bottlenecks, building power plants (primarily coal-fired), strengthening oil and gas exploration and development, improving energy efficiency, and developing rural energy (including small hydropower, solar, geothermal, and biogas). The United States and China are involved in many cooperative efforts in the energy field, which include an agreement to pursue energy information exchange initiatives.

OIL

China produces oil primarily for its domestic market, but also exports crude oil and smaller volumes of petroleum products (mainly crude oil to Japan). The country has been an overall net importer of petroleum (crude plus products) since 1993, and became a net importer of crude oil in 1996. In 1996, China imported 745,000 b/d (454,000 b/d of crude oil and 291,000 b/d of petroleum products) and exported 465,000 b/d (408,000 b/d of crude oil and 57,000 b/d of petroleum products). Imported crude oil comes mostly from Indonesia and the Middle East (mainly Oman, Yemen, and Iran). In 1996, China also imported a small volume of Alaskan oil (just over 2,000 b/d).

About 90 percent of China's oil is produced onshore, primarily by the China National Petroleum Corporation (CNPC). CNPC's largest field -- Daqing, in the Songliao basin of northeastern China -- produces more than 1 million b/d. Since 1993, China has held three onshore licensing rounds to attract foreign investment in western China (particularly the remote Tarim Basin) and in enhanced oil recovery at mature fields. As of late 1996, nearly 1 million square miles of onshore areas were open to foreign companies, 35 of which had signed 30 contracts worth \$770 million. Exxon is the largest foreign acreage holder in the Tarim Basin. In 1996, CNPC signed a contract with Shell for exploration of an area of its third largest producing oil field (Liaohe, in the Bohai Basin) and another with Fracmaster (a Canadian firm) for recompletions of 720 wells at its second largest field (Shengli).

In addition to onshore production, China operates 19 offshore oilfields (including state-owned and joint ventures) under the purview of the China National Offshore Oil Corporation (CNOOC). The offshore petroleum industry has been developed with significant foreign investment (109 contracts with foreign capital commitment of nearly \$3 billion -- nearly 60 percent of total investment in offshore oil exploration and development). Offshore production has been increasing steadily, averaging 0.3 million b/d in 1996. Contributing to this increase was the April 1996 start-up of production at Liahua 11-1, China's largest offshore field discovered to date (estimated reserves of more than 1 billion barrels, production capacity of 65,000 barrels/day). Further increases are anticipated in 1997 with the planned start-up of additional offshore fields, including Xijiang 24-1 and Lufeng 22-1 in the South China Sea and Suizhong 36-1J in Bohai Bay.

Future investment in the development of China's petroleum resources may receive a boost with the recent establishment of the China National Star Petroleum Corporation (Star). Charged with commercializing the activities of oil bureaus and research institutes under China's ministry of geology and mineral resources, Star has begun negotiating with foreign companies on the sale of data from the Tarim Basin and other prospective areas (both onshore and offshore).

The initial experiences of foreign oil companies in the Tarim Basin have not been encouraging, despite China's claims that the area could contain 80 billion barrels or more of oil and 350 trillion cubic feet or more of natural gas. Some observers speculate that reserves may be less than anticipated, while others complain that China has offered only its less promising blocks to foreign investors. For whatever reason, discoveries to date have not been large enough to confirm Tarim as a major oil basin by world standards (as of July 1996, less than 4 billion barrels of oil reserves had been verified; production is slated to reach 88,000 b/d in 1997, compared with 63,000 b/d in 1996). As reserves are developed, significant infrastructure investment will be needed to transport oil long distances over difficult terrain from the Tarim basin to consuming regions.

Territorial disputes in the South China Sea (particularly over the Spratly Islands area) and the East China Sea have complicated offshore oil exploration activities. For example, China protested in April 1996 when Vietnam signed an oil exploration agreement with Conoco for an area of the South China Sea also claimed by China; in March 1997, Vietnam protested when a Chinese prospecting rig entered an area between Vietnam's north central coast and Hainan Island. A positive

development was the July 1996 landmark agreement with Taiwan for joint oil and natural gas exploration in another potential area of contention -- the Taiwan Straits. According to a May 1997 report in the Chinese press, China plans to speed up petroleum exploration in the Bohai Sea off its northern coast while other potentially oil-rich waters are under dispute.

In the downstream oil sector, China's current strategy is to debottleneck and upgrade existing refining capacity rather than build new refineries. Foreign company participation is limited. Arco owns a stake in the state-owned Zhenhai refinery (whose capacity is reported to have been boosted to 460,000 b/d) and French company Total has a 20 percent interest in a new joint venture refinery at Dalian (100,000 b/d). Proposals for additional joint ventures (including one with Royal Dutch/Shell and another with Saudi Aramco and Ssangyong) have languished, while limited access to domestic markets discourages others.

NATURAL GAS

China has only recently begun to tap its reserves of natural gas, and major infrastructure investment will be needed to transport the gas to market. Most natural gas is currently produced in Sichuan province, but China is targeting several large onshore and offshore fields for future development as a substitute for coal and oil. The current 5-Year Plan sets an annual production target of 25 billion cubic meters of natural gas (about 882 billion cubic feet) by 2000.

China's largest offshore gas field, Yacheng 13-1 (with proven reserves of 3 trillion cubic feet) began production in early 1996. The project -- a joint venture among China National Offshore Oil Corporation (51 percent), U.S. company Arco (34.7 percent), and Kuwait Foreign Petroleum Exploration Corp. (14.3 percent) -- supplies natural gas to Hainan Island and to a 2400 megawatt power plant in Hong Kong. It is the first of several planned to supply natural gas to power plants, primarily to areas such as Guangdong province which are a long distance from coal supplies. Dongfang 1-1, with confirmed reserves approaching those of Yacheng 13-1, is currently being developed to supply fertilizer plants on Hainan Island.

Onshore, China's efforts focus on rehabilitating and upgrading the Sichuan fields; developing the Shaan-Gan-Ning field in central-western China and the Tarim basin in the far west; and building pipelines to serve major cities. Longer-term supply options include imports of liquefied natural gas (LNG) or possibly pipeline gas from the former Soviet Union.

COAL

China is both the world's largest producer and consumer of coal, which supplies about 75 percent of the country's total energy needs. The largest coal-consuming sectors are industry and electric power generation. China is also a net exporter of coal to neighboring countries including Japan, Hong Kong, South Korea, and North Korea.

Most of China's coal reserves are located in relatively remote areas of northern China, especially Shanxi Province, and more than half of all recoverable reserves are bituminous. Industry concerns include inefficiency, transportation bottlenecks, and large regional imbalances between supply and demand. In 1996, 38 out of 93 major, state-owned coal mines reported losses. As of April 1997, two profitable mines (Yanzhou and Xinji) were approved for listing on overseas stock markets.

Meeting production targets under the current 5-Year Plan (1.6 billion short tons by 2000) will require development of additional coal deposits and expansion of the country's railway system. China is upgrading locally owned coal mines and establishing wholly state-owned conglomerates which will have access to international financing, foreign trade, and export markets. The Shen Hua Group, the first of these conglomerates, is developing the Shenmu deposit in Shaanxi province in a joint venture with Arco Coal.

Amendments to China's Mineral Resources Law of 1986 encourage additional foreign investment by providing a comprehensive legal framework for coal exploration and exploitation. China is also seeking foreign investment and technology for construction of pilot plants to convert coal to liquid fuel and has approved construction of the country's first coal slurry pipeline (to be built by China Pipeline Holdings Ltd, a joint venture between the China Strategic Investment Group and U.S. companies -- Custom Coals and Williams Technologies Services). In addition, the country plans to develop coalbed methane (with assistance from the United Nations, the U.S. Environmental Protection Agency, and private companies) and strengthen its clean coal technology program.

ELECTRICITY

China's electric power sector has a major role to play in supporting economic growth under the country's current 5-Year Plan. The Ministry of Electric Power estimates that about 15-20 percent of the country's demand for electricity is not being satisfied. To alleviate shortages, the goal is to increase electric generating capacity to a target level of 290 gigawatts by

2000. An estimated 15,000 megawatts of generating capacity will be added each year, at an annual cost of about \$15 billion. About 20 percent of this additional capacity is expected to be funded by foreign investment. China also plans to expand its electric power transmission system, link the country's five regional grids and several provincial grids by 2009, and implement a single national power grid by 2020.

China's first law governing electric power generation went into effect on April 1, 1996. The law recognizes a role for foreign investment, including direct investment in power plants through joint ventures or foreign-owned companies, provided these investments conform to national industrial policy and are in line with projects contained in the Ninth 5-Year Plan and the 2010 Plan. Foreign loans (but no direct foreign investment) are allowed for setting up power grids.

In implementing the current 5-Year Plan, China plans to use high-efficiency generators with capacity of 300 megawatts or higher, and is giving priority to projects in the central and western parts of the country. These projects will continue to make use of China's large domestic coal supplies (about 70 percent of China's existing capacity is coal-fired) while expanding nuclear capacity and taking greater advantage of the country's enormous hydropower potential.

China's largest coal-fired station, consisting of three 660-megawatt units in Dongguan, began operating in August 1996. The project, a Chinese-Hong Kong joint venture, will supply 10.8 billion kilowatt hours annually to Guangdong province. The Yancheng power plant adjacent to coal mines in Shanxi Province is China's first major "coal by wire" project; the first of its six 350 megawatt generators is scheduled to begin operating in 1999. The "coal by wire" program sites power plants adjacent to coal mines rather than near the final consumers. China awarded its first build-operate-transfer contract in 1996 (to France's EDF for construction of the 700-megawatt coal-fired Laibin B project), and plans a second such project (a 600-megawatt plant in Hunan province).

In its most ambitious and controversial electric power project to date, China is proceeding with plans to build the world's largest dam -- Three Gorges -- on the Yangtze River. With costs exceeding \$20 billion, the dam will support 26 hydropower generating units with capacity of 700 megawatts each, for a total of about 18 gigawatts. Target date for completion is 2009. The project has been criticized because it will displace more than 1 million people and threaten wildlife. In May 1996, the U.S. Export-Import Bank announced a decision to deny financing assistance to U.S. companies

bidding on the project, due to concerns over the dam's environmental impact.

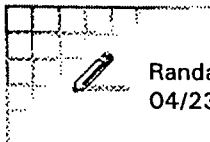
China operates two nuclear power plants - Qinshan and Daya Bay - whose combined capacity of 2.1 gigawatts currently supplies less than 1 percent of the country's total energy needs. During 1996, China announced plans to advance its nuclear program by 10 years -- the target of 20 gigawatts in new capacity is now 2010 instead of 2020. This includes 1.8 gigawatts using French technology at Lingao, 2 gigawatts using Russian technology at Liaoning and 1.4 gigawatts using Canadian technology at Qinshan.

Natural gas is not now used extensively in the electric power sector, but could become increasingly important as China seeks less-polluting sources of electricity for

its growing economy. Several liquefied natural gas (LNG) projects are under consideration.

ENVIRONMENT

The coal and oil industries are among the major polluting industries being targeted in China's plan to curb pollution and limit environmental damage, at a cost of nearly \$40 billion over the next 5 years. The country is the world's second largest emitter of carbon, due primarily to its economy's high dependence on coal. Although China's energy consumption per unit of output has been cut nearly in half since 1970, the country's major industries, including electric power generation, continue to use energy far more intensively than in most developed countries. China's sustainable development goals, outlined in its Agenda 21 program, include increased emphasis on energy efficiency and renewable power sources (hydroelectricity, solar, etc.).



Randall W. Lutter
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Record Type: Record

To: Adele C. Morris/CEA/EOP, Joseph E. Aldy/CEA/EOP
cc: Zachary M. Candelario/CEA/EOP, Jon D. Haveman/CEA/EOP
Subject: DOE co2 report

Zach: can you download the entire report and make copies for all of us?
Jon: You should put this article in Janet's briefing book for China.

DNA

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Regulation, Law & Economics

Energy

Carbon Emissions Predicted to Increase Substantially by 2020, DOE Report Says

Worldwide energy consumption is expected to grow 75 percent between 1995 and 2020, resulting in substantial increases in carbon emissions, according to a Department of Energy report released April 22.

According to a DOE official describing the report, world carbon emissions are expected to exceed 1990 levels by 44 percent in 2010, and by 81 percent in 2020. However, if industrialized countries adhere to the 1997 Kyoto Protocol, a climate change treaty, carbon emissions would probably be 32 percent greater than 1990 levels by 2010 rather than 44 percent greater, the official, Jay Hakes, said.

Hakes is the administrator of the Energy Information Administration, an independent research office within DOE. He spoke at a press conference to release the report *International Energy Outlook 1998: With Projections Through 2020*.

By 2020, total world energy consumption will reach 639 quadrillion British thermal units, according to the report. Much of the projected growth is attributable to expected rapid increases in energy use in the developing world, especially Asia, the report said.

The baseline projections in the report, prepared by DOE's Energy Information Administration, do not reflect the Kyoto Climate Change Protocol, Hakes said. But the report does show some possible impacts of compliance with the Kyoto Protocol, he said.

Under the Kyoto Protocol, industrialized nations—including countries of the former Soviet bloc—collectively are to reduce their emissions of greenhouse gases by 5.2 percent below 1990 levels by 2008-2012. The greenhouse gases covered by the Kyoto agreement are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The Kyoto protocol sets emission control targets only for industrialized countries.

Asian Growth

Projections in the report were not affected by recent Asian economic problems, Hakes said. "We think these problems are probably temporary, and will last several years."

The long-term growth of Asia's economy is predicted by the report as "robust." By 2020, energy use in "developing Asia," which includes China and India but not Japan, Australia, and New Zealand, will surpass that of North America by 36 percent, the report said. Today total energy use in developing countries of Asia is 33 percent below that of North America.

Africa, Central and South America, and the Middle East also will contribute to the energy increase, Hakes said. By 2020, energy consumption in developing countries is expected to exceed that of industrialized countries by almost 6 percent, he said.

In contrast, the industrialized world is projected to experience moderate growth in energy use, attributable to relatively stable employment and population growth, Hakes said.

Oil is expected to decline from being 39 percent of the world's share of total energy demand in 1995 to 37 percent in 2020 as natural gas becomes more available, he said.

Natural Gas, Nuclear Energy

Natural gas is projected to be the fastest-growing energy source over the 25-year period, over oil, coal, and nuclear power, according to the report. Natural gas is expected to grow from a 21 percent share of the world's energy in 1995 to 27 percent in 2020, Hakes said.

Low fossil fuel prices are expected to continue to hamper the development of renewable energy sources, but those sources are expected to retain an 8 percent share of world energy consumption, the report said. Use of renewables for electricity generation is expected to double over the next 25 years, supported by the scheduled completion of large-scale hydroelectric dams in developing Asia, according to the report.

Nuclear power will decline as a share of the world's energy production because of market competition from natural gas, public concern about the safety of nuclear reactors, and problems associated with the disposal of nuclear waste, the report said. The use of nuclear power may be expanded in the Far East but this will be more than offset by retirement of existing U.S. nuclear plants. Replacement by new units is not expected in the United States, according to the report.

World Carbon Emissions

If presumptions of the report hold true for world energy consumption, annual carbon emissions will increase by 2.5 million metric tons each year between 1990 and 2010, and another 2.1 billion metric tons each year between 2010 and 2020, Hakes said. Coal would contribute 1.7 billion metric tons to the overall increase between 1990 and 2010, oil 1.5 billion metric tons, and natural gas 1.4 billion metric tons, he said.

Developing countries are expected to account for more than three-fourths of the world's increase in carbon emissions between 1990 and 2020, he said.

On April 21, Secretary of State Madeleine Albright announced she will appoint a special coordinator for U.S. diplomatic efforts to encourage developing countries to limit greenhouse gas emissions.

Electricity Consumption

Net electricity consumption is predicted to increase from a level of 12 trillion kilowatt hours in 1995 to 23 trillion kwh in 2020, a 97 percent increase, according to the report. To accommodate this increase, nearly

6,700 new power plants would have to be built, the report said. Developing Asia would require more than 40 percent of these new plants to meet its expected growth in electricity demand.

Electricity growth demand in developing countries is expected to more than triple from 1995 to 2020, the report said. While electricity growth is expected to be slower in industrialized countries, per capita consumption is expected to rise. In the United States, per capita consumption is expected to grow from 11,800 kwh in 1995 to 13,300 kwh in 2020.

In developing Asia, per capita electricity consumption is projected to increase 164 percent, from 600 kwh to 1,700 kwh, over the 25-year projection period, according to the report.

In Central and South America, per capita electricity use is expected to rise from 1,500 to 2,900 kwh over this time period, a 94 percent increase, the report said.

Copies of the report (DOE/EIA-0484(98)) are available from the U.S. Government Printing Office at (202) 512-1800 or from EIA's National Energy Information Center at (202) 586-8800. The report is also available on the World Wide Web at <http://www.eia.doe.gov/leo98/home.html>.



By Patricia Ware

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Highlights

Growth in energy use is projected worldwide through 2020. The demand for electricity in homes, business, and industry is growing in all regions, as is the demand for petroleum-powered personal transportation.

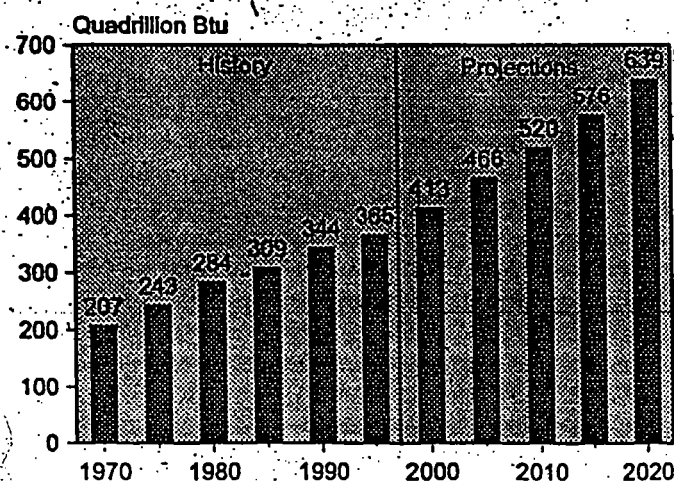
The *International Energy Outlook 1998 (IEO98)* reference case forecast indicates that by 2020, the world will consume three times the energy it consumed 28 years ago in 1970 (Figure 2). Much of the projected growth in energy consumption is attributed to expectations of rapid increases in energy use in the developing world—especially in Asia. Although the economic downturn in Asia that began in mid-1997 and continues into 1998 has lowered expectations for near-term growth in the region, the forecast still suggests that almost half the world's projected increase in energy consumption will be in developing Asia (Figure 3). Strong long-term economic growth in the Asia Pacific is expected to result in improved standards of living which, in turn, will mean increased use of energy for a variety of residential and commercial purposes and for personal transportation. By 2020, the projected energy consumption in developing Asia (including China and India, but excluding Japan, Australia, and New Zealand) surpasses that of all North America by more than 50 quadrillion Btu (36 percent).

Total world energy consumption in the *IEO98* reference case is projected to reach 639 quadrillion Btu in 2020, an

increase of almost 274 quadrillion Btu (75 percent) over 1995 levels (Figure 2). The developing world will account for 174 quadrillion Btu (64 percent) of the world's increment in energy use. In 1995, energy consumption in the industrialized countries exceeded that in the developing countries by 86 quadrillion Btu (76 percent), but by 2020 the developing countries surpass the industrialized countries by 16 quadrillion Btu (6 percent) (Figure 4). Developing Asia accounted for only 20 percent of the world's energy use in 1995, but its share grows to over 30 percent by 2020 in the *IEO98* reference case (Figure 5), with an increment of 128 quadrillion Btu (178 percent) projected for the countries of that region over the forecast.

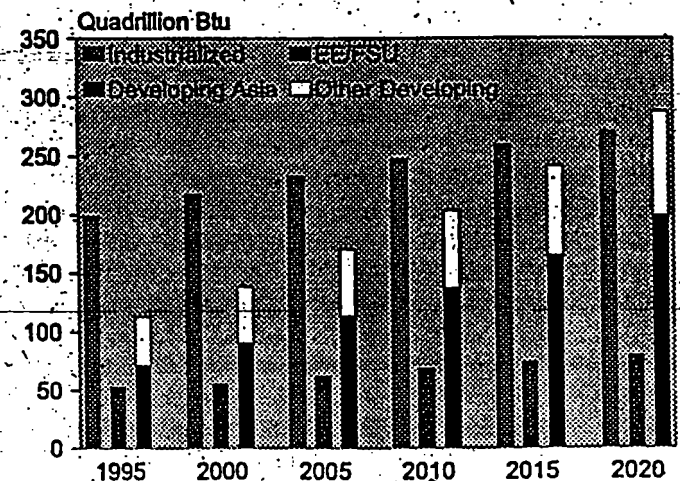
Two developments in 1997 may substantially impact future energy demand levels: the deep economic recession in Southeast Asia and the potential consequences of the Kyoto Climate Change Protocol. The Asian economic downturn has resulted in some short-term reductions in expectations for the energy use there. No adjustments were made to the projections to account for the effects of the Kyoto Protocol, however, because the *IEO98* forecast is based on current laws and regulations.

Figure 2. World Energy Consumption, 1970-2020



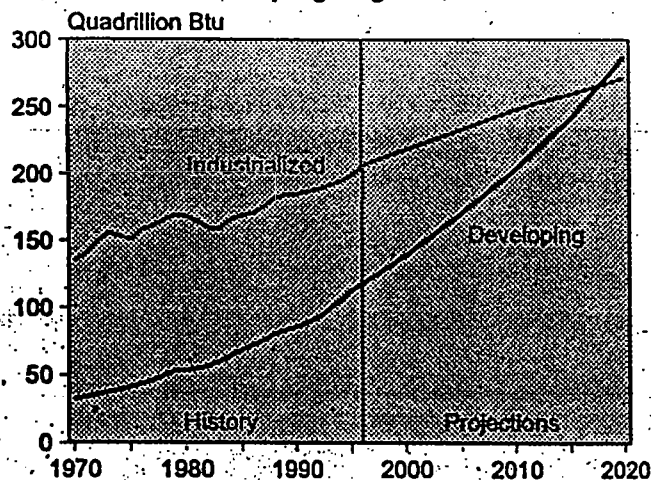
Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Statistics Database* and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, *World Energy Projection System* (1998).

Figure 3. World Energy Consumption by Region, 1995-2020



Sources: 1995: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, *World Energy Projection System* (1998).

Figure 4. Energy Consumption in Industrialized and Developing Regions, 1970-2020



Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

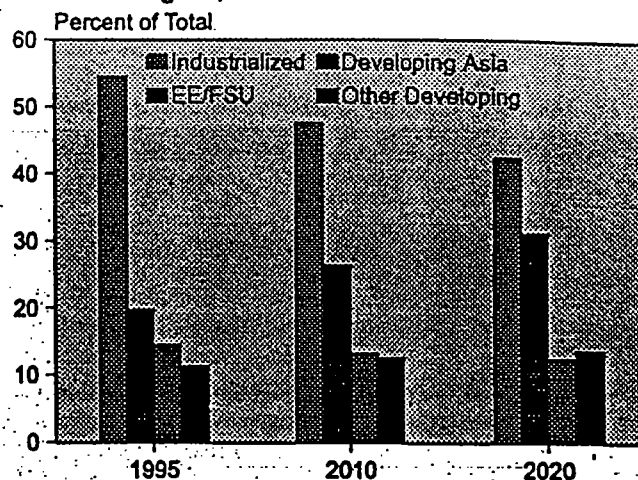
None of the participating countries had ratified the treaty at the time this report was prepared for publication.

The Kyoto Protocol could profoundly affect energy growth in the industrialized countries. For the emissions targets specified by the Protocol to be achieved by industrialized countries solely through reduction of fossil fuel use, projected energy demand in 2020 would have to be scaled back by 40 to 60 quadrillion Btu—equivalent to between 20 and 30 million barrels of oil per day. The expectation is that, with fuel-switching opportunities, emissions trading, and other offsets allowed under the Protocol, such as reforestation, a more modest reduction in fossil fuel use will be needed.

The economic crisis in Southeast Asia may put some of the projected increase in energy use for developing Asia at risk. The countries most harmed by Asia's currency and debt crisis include South Korea, Indonesia, Thailand, and Malaysia, which currently account for just under 20 percent of the energy use in developing Asia. The recession has already caused delays of many energy projects in those countries, and a quick economic recovery will be needed to support their completion.

If world energy consumption reaches the levels projected in the *IEO98* reference case, annual carbon emissions will increase by 4.6 billion metric tons between 1995 and 2020 (Table 1). According to this projection, world carbon emissions would exceed 1990 levels by 81 percent at the end of the forecast period. By 2010, emissions in the developing world are projected to be nearly equal to those of the industrialized nations (Figure 6). Between 1990 and 2010, 78 percent of the world's increment in carbon emissions is attributed to the developing

Figure 5. World Energy Consumption Shares by Region, 1995-2020



Sources: 1995: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

countries. If the Annex I countries that are parties to the Kyoto Protocol were able to achieve the proposed target reductions, the forecast for their emissions would be altered; but emissions levels worldwide would continue to increase. Should the Annex I countries meet their targets exactly, their projected level of emissions could be reduced by as much as 700 million metric tons. Many issues remain to be resolved, however, with regard to credits for controlling greenhouse gases other than carbon dioxide, sequestering carbon through forestry and other activities, and trading emissions rights with countries whose emissions are below the caps set by the Kyoto agreement and related protocols.

The long-term projections for world oil prices in the *IEO98* reference case remain virtually unchanged from those in last year's report (Figure 7). The long-term trend in this year's forecast shows oil prices rising slowly in real terms, reaching about \$22.00 (constant 1996 U.S. dollars) per barrel in 2020 from the current price of \$17.00. The year-end 1996 price was \$24.00 a barrel. General perceptions are that near-term price risks are more heavily weighted on the downside, rather than the upside; many analysts have lowered their near-term projections by \$1.00 or more per barrel over at least the next year, a sharp reversal of the views held in early 1997. In the next year or so, prices are expected to recover from present levels as the demand for oil begins to grow more rapidly, especially in developing regions.

Over the longer term, oil prices are expected to remain relatively low throughout the projection period. The recent expansion of non-OPEC oil production is expected to continue in the short term, given that technological

Table 1. Energy Consumption and Carbon Emissions by Region, 1990-2020

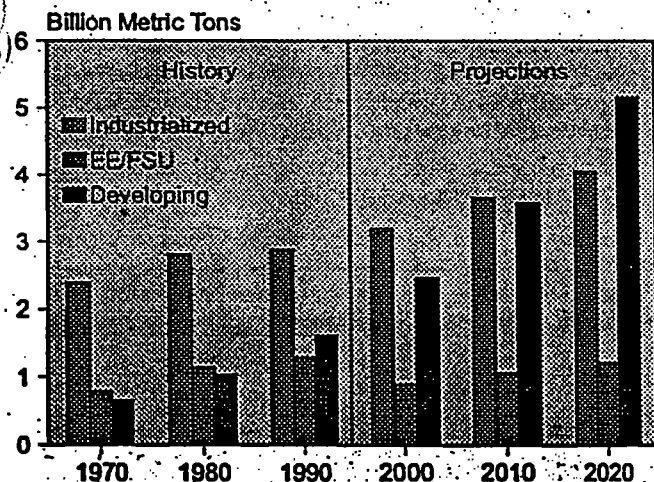
Region	Energy Consumption (Quadrillion Btu)				Carbon Emissions (Million Metric Tons)			
	1990	1995	2010	2020	1990	1995	2010	2020
Annex I Countries								
Industrialized ^a	179.8	193.7	238.7	260.5	2,807	2,851	3,535	3,907
EE/FSU ^b	73.6	53.2	69.0	80.4	1,290	866	1,072	1,223
Total	253.4	246.8	307.6	340.9	4,097	3,717	4,607	5,130
Non-Annex I Countries								
Asia	51.4	71.8	137.4	199.4	1,065	1,427	2,603	3,835
Other	39.0	46.9	74.7	99.1	624	692	1,120	1,482
Total	90.4	118.7	212.0	298.5	1,689	2,121	3,723	5,317
Total World	343.8	365.6	519.6	639.4	5,786	5,841	8,330	10,447

^aExcludes Mexico. Mexico is included in Non-Annex I Other.

^bIEO98 does not project separately for countries in the EE/FSU. However, emissions from Annex I countries in the EE/FSU region currently account for 87 percent of total regional emissions. Hence, this number is slightly overstated.

Sources: History: Energy Information Administration (EIA), *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

Figure 6. World Carbon Emissions by Region, 1970-2020

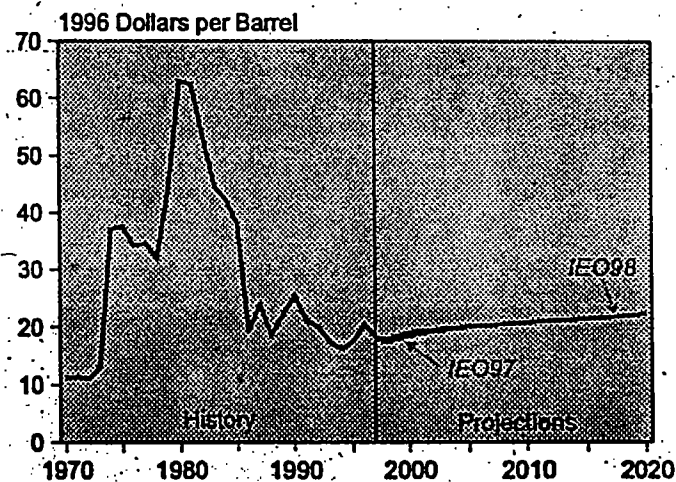


Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

improvements have expanded non-OPEC production possibilities. Nevertheless, OPEC producers are projected to gain share in the world oil production market, providing about 52 percent of the world's oil supply in 2020, compared with 39 percent in 1996.

There is now agreement among many analysts that resources are not a key constraint in satisfying substantial increases in oil demand through 2020. Rather more important to the development of oil markets are political, economic, and environmental circumstances. Uncertainties with regard to the final settlement of sanctions in

Figure 7. Comparison of 1997 and 1998 World Oil Price Projections



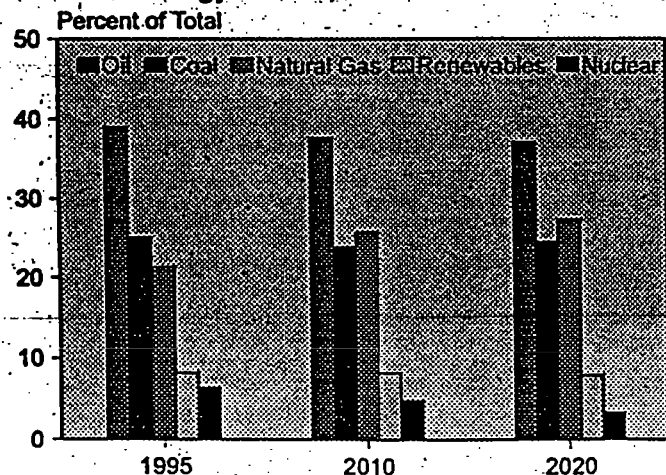
Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

Iraq and the development of suitable transportation infrastructure for the marketing of oil from the Caspian region are two obvious examples; the future behavior of OPEC is another. OPEC recently increased its output quota by 10 percent, from 25 million barrels per day to 27.5 million barrels per day. While some argue that the adjustment—led by Saudi Arabia—signals a determination by the Saudis to improve their share of the world oil production market, others suggest that it merely reflects an effort by OPEC to develop a path for future production levels that will accommodate the continued expansion of world oil markets.

Two current developments are likely to contribute to a situation of excess supply in world oil markets in the short term. On the demand side, the onset of the Asian recession portends a slowing of oil demand growth in a region that currently accounts for one-fourth of the world's oil consumption. On the supply side, the Iraqi crisis—if settled peacefully—could lead to an acceleration of oil exports even as oil prices decline. That is, since allowable Iraqi exports are defined in dollars, as the oil price declines, more oil supplies can enter the market. Increases in the dollar allowance for export earnings also raise the prospect of oversupply.

Large increases in oil consumption are expected in the IEO98 reference case. Between 1995 and 2020, oil demand grows at an average rate of 2 percent annually, resulting in an increment of more than 45 million barrels per day. Even given this growth in demand, oil's share of total energy use declines over the projection period, falling from 39 percent in 1995 to 37 percent in 2020, as natural gas becomes an increasingly powerful competitor to oil in all end uses except transportation (Figure 8). In the industrialized countries, oil use grows by 1.1 percent per year—mainly in the transportation sector, where it has limited competition. Oil use in the developing countries is projected to grow by 3.5 percent annually, increasing in all end-use sectors. Higher standards of living are expected to encourage increased demand for personal transportation and larger and better equipped homes in the world's developing countries, many of which do not have natural gas distribution infrastructures that would allow competition with oil.

Figure 8. World Energy Consumption Shares by Energy Source, 1995-2020



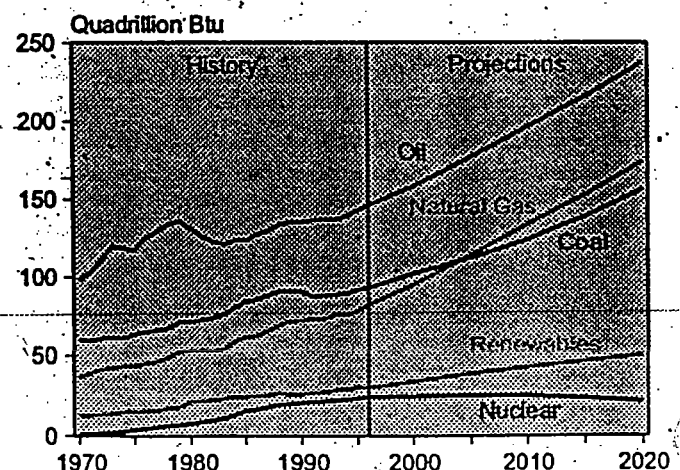
Sources: 1995: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

Natural gas demand more than doubles over the projection period, reaching 172 trillion cubic feet in 2020. Worldwide, gas use grows faster than any other primary energy source, 3.2 percent per year compared to about 2 percent for oil and coal. On a Btu basis, worldwide gas consumption surpasses coal consumption by 2005 in the reference case. By 2020, natural gas demand is 11 percent higher than coal demand (Figure 9). Much of the increment in gas usage will fuel electricity generation, particularly in the industrialized countries, where natural gas can replace the other, relatively more carbon-intensive fossil fuels.

Gas demand is expected to grow most quickly in the world's developing countries. In developing Asia, natural gas consumption grows by 7 percent annually even given the region's recent economic turmoil. Central and South America also are expected to experience fast-paced growth in gas demand, by 7 percent annually between 1995 and 2020. In Brazil alone, gas use increases by 14 percent per year in the reference case. There is robust activity in the region to develop the infrastructure needed to deliver natural gas to industrial consumers and electric power generators. Construction on several major pipelines began in 1997, including work on the \$2 billion Bolivia-Brazil pipeline.

Coal's role in energy use worldwide has shifted substantially over the decades, from a fuel used extensively in all sectors of the economy to one that is now used primarily for electricity generation and in a few key industrial sectors, such as steel, cement, and chemicals.

Figure 9. World Energy Consumption by Energy Source, 1970-2020



Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Statistics Database* and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

Coal consumption is expected to increase by about 3.5 billion short tons over the next 25 years (an increase of about 69 percent).

The coal share of total energy consumption decreases only slightly, from 25 percent in 1995 to 24 percent in 2020, mostly because of large increases projected in developing Asia. Coal use is expected to decline in Eastern Europe and the former Soviet Union (EE/FSU) and grow slowly in the industrialized world. The relatively stable outlook portrayed for coal in the IEO98 forecast could change substantially as a result of the reductions in carbon emissions targeted in the Kyoto Protocol. If the proposed reductions occur, the coal industry could face a rapidly declining market for its product in the years ahead.

Worldwide nuclear capacity is projected to increase from 351 gigawatts in 1995 to 356 gigawatts in 2005, before declining to 304 gigawatts in 2020. Aggressive plans to expand nuclear capacity, mainly in the Far East, drive the near-term increase; but retirements of existing units—particularly in the United States, where replacement by new nuclear units is not expected—outweigh the expected development in Asia.

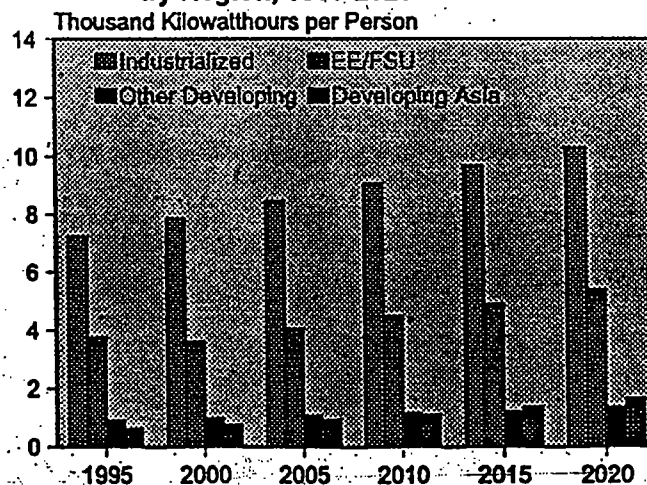
Nuclear power provided 17 percent of total electricity generation in 1996. In nine countries it provided more than 40 percent of electricity generation. Nevertheless, market competition from natural gas, public concern about the safety of nuclear reactor operations, and problems associated with the disposal of nuclear waste are constraining the expansion of nuclear power programs in many nations. The widespread trend toward privatization and deregulation of the electric utility sector has also undermined the viability of the nuclear option, because of the high costs associated with building and operating nuclear power plants. It is possible, however, that ratification of the Kyoto Protocol could change the outlook for nuclear power. Industrialized countries could conceivably extend the lives of their nuclear plants in efforts to constrain greenhouse gas emissions.

Low fossil fuel prices are expected to continue to hamper the development of renewable energy sources. Again, however, the impact of the Kyoto Protocol on renewables initiatives is not yet known, and many of the industrialized Annex I countries may turn to renewables to help meet their carbon emissions reduction targets. Although the IEO98 projections do not address the potential of hydroelectricity and other renewable energy sources under the terms of the Protocol, consumption of

renewables in the reference case is projected to grow by 67 percent, to about 50 quadrillion Btu in 2020. While renewable energy sources are not expected to gain market share, they are projected to retain an 8-percent share of world energy use in 2020. Large-scale hydroelectric projects in developing Asia, such as China's 18.2-gigawatt Three Gorges Dam project scheduled for completion in 2009, support expectations that the use of renewables for electricity generation will more than double in that region over the next 25 years.

Net electricity consumption exceeds 23 trillion kilowatt-hours in the IEO98 reference case in 2020, a 97-percent increase from the 1995 level of 12 trillion kilowatt-hours. Growth in electricity demand in developing countries is projected to more than triple between 1995 and 2020, and even though growth is expected to be slower in the industrialized countries, per capita consumption is expected to rise as new uses for electricity proliferate among residential, commercial, and industrial consumers (Figure 10). Per capita electricity consumption in the industrialized countries grows from 7.2 thousand kilowatt-hours per person in 1995 to 10.3 thousand kilowatt-hours per person in 2020, a 42-percent increase. The greatest gains are expected in developing Asia and in Central and South America, where rising standards of living are leading to greater electrification and intensive use of modern appliances, space heating, air conditioning, and lighting.

Figure 10. Net Electricity Consumption per Capita by Region, 1995-2020



Sources: 1995: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

relatively high energy use per dollar of output reflects heavy reliance on production from energy-intensive industries.

Given historic differences across regions, what can be expected in the future? The reference case projections assume declining ratios of energy use per dollar of GDP. Thus, energy demand growth is projected to trail economic growth. While world economic growth is projected to average 3.1 percent per year between 1995 and 2020, energy growth is projected at 2.3 percent per year. This assumes a nearly 25-percent reduction in energy intensity worldwide, with declines of one-third or more in the developing countries and in the EE/FSU.

The decline in energy-to-GDP elasticity for developing nations is projected to continue through 2020, but at a slower rate than for the industrialized nations (Figure 19). The projected decline in energy intensity is based on the assumption that energy-efficient technologies used in the industrialized world will also be adopted in the developing world. The widespread use of efficient technology could come about through pressures for economic efficiency as developing and transitional economies become more market-driven and more integrated into the global economy. It is also possible, however, that the drive for modern living standards could lead to significant further increases in energy use per capita, pushing world energy requirements well beyond the reference case projections. In recent years, most projections for developing countries have indicated an expectation of declining energy intensities. For many countries, however, economic growth and energy growth have moved together, making it necessary to move back the expected dates for declines in energy

growth relative to GDP growth, and causing upward revisions to expectations of world energy requirements.

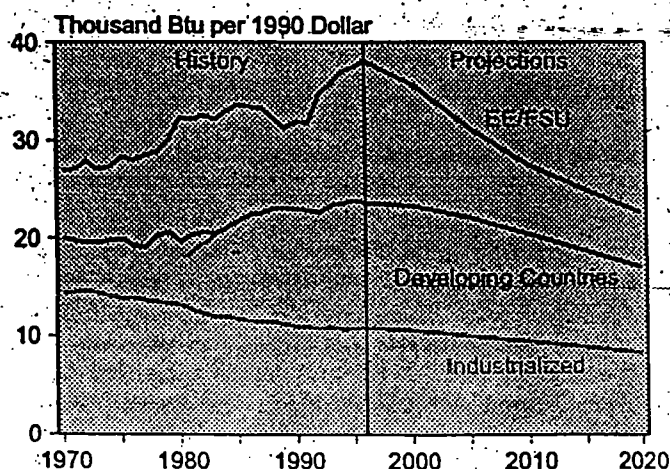
On the other hand, recent commitments by industrialized countries to reduce greenhouse gas emissions below 1990 levels, to be achieved, would require substantial reductions in the ratio of energy growth to GDP growth. For the commitments to be achieved through reduced energy use alone, the projected rate of decline in energy intensity would have to nearly triple relative to current expectations.

Emissions of Greenhouse Gases and the Kyoto Protocol

In 1992, a Framework Convention on Climate Change was endorsed in Brazil, with a stated aim of stabilizing atmospheric concentrations of greenhouse gases. The initial agreement called for voluntary actions by Annex I countries (including all industrialized countries, except Mexico, and including Belarus, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Slovenia, and the Ukraine) that would stabilize greenhouse gas emissions at 1990 levels by 2000.

By 1995 it was recognized that progress toward emissions stabilization among the Annex I countries was insufficient and that additional steps were needed to identify a path toward emissions stabilization for the industrialized countries. As a consequence, new negotiations were initiated under what came to be known as the "Berlin Mandate" to elaborate and agree upon targets and timetables for reducing greenhouse gas emissions after 2000.

Figure 19. Energy Intensities by Region, 1970-2020



Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

On December 11, 1997, in Kyoto, Japan, the parties to the Framework Convention agreed to a new set of commitments for reducing greenhouse gas emissions. The agreement—the Kyoto Protocol—may signal a significant change in the level of effort among industrialized countries to reduce greenhouse gas emissions [3]. The pledge, if realized, will markedly reduce or change energy use among signatory participants. If the agreement proves to be meaningful, substantial shifts in the composition of energy supply away from high-carbon fuels, substantial reductions in energy use intensity, or some combination will have to be achieved in developed countries. Table 8 summarizes the extent of change projected to be required relative to current reference case projections for countries committing to fixed targets under the Protocol. It should be noted that the percentage reduction in emissions that a country would have made relative to the 1990 levels could change, based on sinks and offsets that must be evaluated for each country. Further, international carbon trading permits could lessen the cost of compliance or the severity of the reductions.

Table 8. Carbon Emissions in the Annex I Countries, 1990 and 2010, and the Effects of Kyoto Protocol in 2010

Country	Million Metric Tons Carbon				Percent Change	
	1990 Emissions	2010 Baseline Projection	2010 Kyoto Target	Reduction from 2010 Baseline	From 1990	From 2010 Baseline
Annex I Industrialized Countries						
United States	1,346	1,803	1,252	552	-7	-31
Canada	126	170	118	52	-6	-30
Japan	274	342	258	85	-6	-25
Western Europe	871	1,101	893	208	-8	-19
Australasia	90	119	97	22	8	-18
Total	2,807	3,535	2,618	917	-7	-26
Annex I Transitional Economies^a						
Former Soviet Union	991	792	991	-199	0	25
Eastern Europe	299	280	277	3	-7	-1
Total	1,290	1,072	1,268	-196	-2	18
Total Annex I Countries	4,097	4,607	3,886	721	-5	-16

^aIncludes Non-Annex I countries. *IEO98* does not project emissions for separate countries within the EE/FSU region; however, Annex I countries in the EE/FSU region currently account for about 87 percent of the region's total emissions.

Source: Energy Information Administration, *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998), and World Energy Projection System (1998).

To achieve the targets proposed under the Kyoto Protocol, emissions in 2010 would have to be 26 percent lower than those currently projected for the industrialized Annex I countries in the *IEO98* reference case (Table 8). In the United States and Canada alone, meeting the targets would require reductions of 31 and 30 percent, respectively, from 2010 projected emissions. In contrast, emissions in the EE/FSU are so much lower now than they were in 1990 that it is doubtful they could be restored to those levels by 2010. If energy consumption in the countries of the FSU grew as shown in the reference case forecast, carbon emissions would remain about 25 percent below levels allowed under the Kyoto Protocol, which requires no reductions to the 1990 emissions levels in the transitional economies of the FSU.² Even in Eastern Europe—where countries are expected to hold emissions to 7 percent below their 1990 levels by 2010—carbon emissions must be reduced by only 1 percent from the reference case projections.

There are many possible paths to the fulfillment of national commitments under the Protocol. In the energy arena, nonfossil energy may be substituted for fossil fuels. Alternately, high-carbon fuels—notably coal—may be replaced by low-carbon fuels—particularly natural gas. Further, improved end-use efficiency or reduced reliance on energy-intensive activities may serve to reduce the link between rising economic activity and increased energy consumption. Emissions can also be reduced through reductions in the demand for

energy services, such as lowering thermostats, driving cars less, or switching to mass transit.

Actions not related to energy may also promote programs toward the goals set out by the Protocol. In addition to carbon dioxide, five categories of gases were identified as greenhouse gases to be controlled and for which control credits could be counted in moving toward Protocol targets (see box). The gases include methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). Reductions for carbon dioxide, methane, and nitrous oxide—gases which represent the bulk of all emissions—will be calculated from a 1990 baseline. Reductions of other gases will be credited in comparison with a 1995 baseline. In addition, actions which enhance carbon storage or sequestration in forests may also provide credit toward targeted commitments. Lastly, carbon permits may be earned through international agreements to moderate the degree of reduction needed to be judged in compliance with national commitments. The implementation of the latter path to compliance is subject to further negotiation and specification over the next year.

Since fossil fuel use is the major source of anthropogenic greenhouse gas emissions (for example, 84 percent of U.S. greenhouse gas emissions consist of carbon produced by energy-related activities [4, p. ix]), it is difficult to contemplate achievements of commitments without

² Note that not all the countries of the former Soviet Union agreed to the Kyoto Protocol. Russia, the Ukraine, and the three Baltic Republics (Estonia, Latvia, and Lithuania) acceded to the Protocol. Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, and Uzbekistan did not.

Greenhouse Gases Targeted Under the Kyoto Protocol

A number of greenhouse gases have been targeted for reduction under the Kyoto Protocol. Provided below is a description of each of the targeted greenhouse gases and, whenever possible, an estimate of world emissions of each gas [4, pp. 3-5]. Carbon dioxide is the most abundant greenhouse gas. Others, while volumetrically less significant, can have disproportionate effects in trapping heat in the Earth's atmosphere.

Carbon Dioxide. Carbon is a common element on the planet, and immense quantities can be found in the atmosphere, in soils, in carbonate rocks, and dissolved in ocean water. Records from Antarctic ice cores indicate that the carbon cycle has been in a state of imbalance for the past 200 years, with carbon dioxide emissions into the atmosphere exceeding absorption. As a result, atmospheric carbon dioxide concentrations have been rising steadily.

The most important natural sources of carbon dioxide are releases from the oceans (90 billion metric tons per year), aerobic decay of vegetation (30 billion metric tons per year), and plant and animal respiration (30 billion metric tons per year) [5]. Known anthropogenic sources account for 7 billion metric tons of carbon per year. The principal anthropogenic source is the combustion of fossil fuels, which accounts for about 75 percent of total anthropogenic emissions of carbon worldwide.

Methane. Methane (CH_4) is also a common compound. Methane is released primarily by anaerobic decay of vegetation, by the digestive tracts of termites in the tropics, and by several other lesser sources. The main anthropogenic sources are leaks from the production of fossil fuels, human-promoted anaerobic decay in landfills, and the digestive tracts of domestic animals. Known and unknown sources of methane are estimated to total about 600 million metric tons annually; known sinks (i.e., absorption by natural processes) total about 560 million metric tons. The annual increase

in methane concentration in the atmosphere accounts for the difference of 35 to 40 million metric tons.

Nitrous Oxide. The sources and absorption of nitrous oxide (N_2O) are much more speculative than those for other greenhouse gases. The major sources are thought to be bacterial breakdown of nitrogen compounds in soils, particularly forest soils, and fluxes from ocean upwellings. The primary human-made sources are enhancement of natural processes through application of nitrogen fertilizers, combustion of fuels, and certain industrial processes. The most important sink is thought to be decomposition in the stratosphere. Worldwide estimated known sources of nitrous oxide total 13 to 20 million metric tons annually, and known sinks total 10 to 17 million metric tons.

Hydrofluorocarbons. Hydrofluorocarbons (HFCs) are engineered chemicals that do not exist in nature. They were rare prior to 1990 but since then have come into widespread use as refrigerants and blowing agents, replacing chlorofluorocarbons, which are being phased out under the terms of the 1987 Montreal Protocol. The most commonly used HFC, HFC-134a, is now the standard refrigerant used in automobile air conditioners and home refrigerators in the United States.

Perfluorocarbons. Perfluorocarbons (PFCs) are chemicals composed of one or two carbon atoms and four to six fluorine atoms, containing no chlorine. They are emitted as a byproduct of aluminum smelting and are also used in semiconductor manufacturing.

Sulfur Hexafluoride. Sulfur hexafluoride (SF_6) is an engineered chemical, produced in very small quantities, which has direct radiative forcing effects. It is a colorless gas, soluble in alcohol and ether and slightly soluble in water. SF_6 is used as a dielectric in electronics and is also a fugitive emission from magnesium smelting. Worldwide emissions in 1995 were about 5,700 metric tons.

The "carbon cycle" is the process by which carbon dioxide (CO_2) is extracted from the air by plants and decomposed into carbon and oxygen, with the carbon being incorporated into plant biomass and the oxygen released into the atmosphere. Plant biomass, in turn, ultimately decays (oxidizes), releasing carbon dioxide back into the atmosphere, or storing organic carbon in soil or rock. There are vast exchanges of carbon dioxide between the ocean and the atmosphere, with the ocean absorbing carbon from the atmosphere and plant life in the ocean absorbing carbon from water, dying, and spreading organic carbon on the sea bottom, where it is eventually incorporated into carbonate rocks.

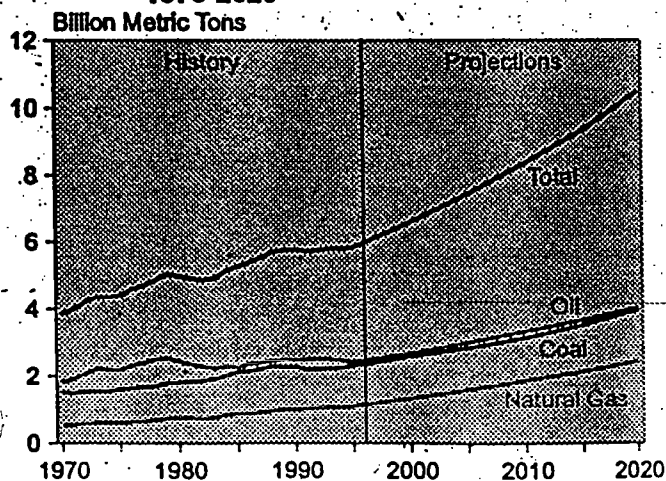
marked changes in energy supply and usage. As noted earlier, if the industrialized Annex I countries were to meet emissions targets specified by the Kyoto Protocol solely by reducing the consumption of fossil fuels, the reference case forecast could face decreases in energy use in the range of 40 to 60 quadrillion Btu by 2010. However, because fuel switching and emissions trading will also be used to reduce a country's emissions, the potential fossil fuel consumption reductions noted above are probably overstated.

Carbon Emissions

Because of the recency of the Kyoto Protocol agreement and the many possible paths to compliance, no explicit adjustment has been made to the *IEO98* forecasts, which were based on current laws and regulations in effect on October 1, 1997. The countries that agreed to the reductions in the Protocol had not yet ratified or even signed the treaty at the time this report was prepared for publication.

If energy consumption grows to levels projected in the reference case, annual carbon emissions will reach 8.3 billion metric tons by 2010 and 10.4 billion metric tons by 2020 (Figure 20). The resulting emissions would exceed 1990 levels by 44 percent in 2010 and by 81 percent in 2020. Emissions are projected to grow by 2.5 billion metric tons between 1990 and 2010 and another 2.1 billion metric tons by the end of the projection period. Coal contributes 1.7 billion metric tons to the overall increase between 1990 and 2020, oil 1.5 billion metric tons, and natural gas 1.4 billion metric tons.

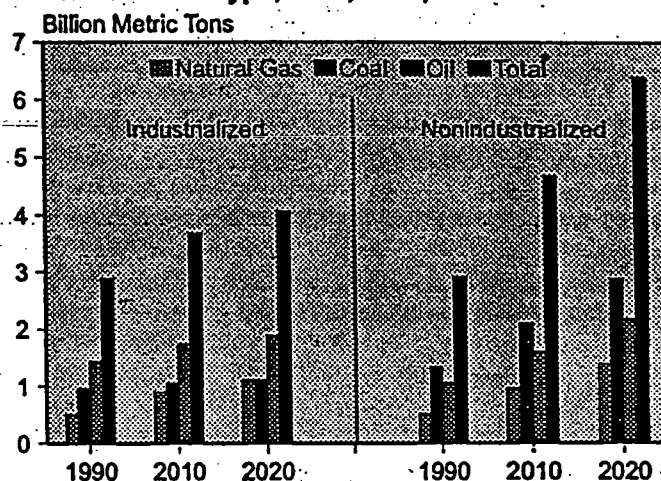
Figure 20. World Carbon Emissions by Fuel Type, 1970-2020



Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

Emissions in the industrialized world increase by 1.2 billion metric tons between 1990 and 2020, reaching 4.1 billion metric tons at the end of the forecast period (Figure 21). About half of the increase in emissions is attributed to additional use of natural gas. Carbon emissions from natural gas use are almost equivalent to those from coal by the end of the projection period, reflecting the strong growth in natural gas consumption relative to coal. In 1990, carbon emissions from natural gas use were only about half of those from coal use. Oil remains the dominant source of carbon emissions in the industrialized world, where petroleum remains the main source of transportation fuel. Emissions from petroleum products, which accounted for 49 percent of total emissions in the industrialized countries in 1990, are projected to decline to 46 percent by 2020 as a result of increases in natural gas consumption over the forecast period.

Figure 21. World Carbon Emissions by Region and Fuel Type, 1990, 2010, and 2020

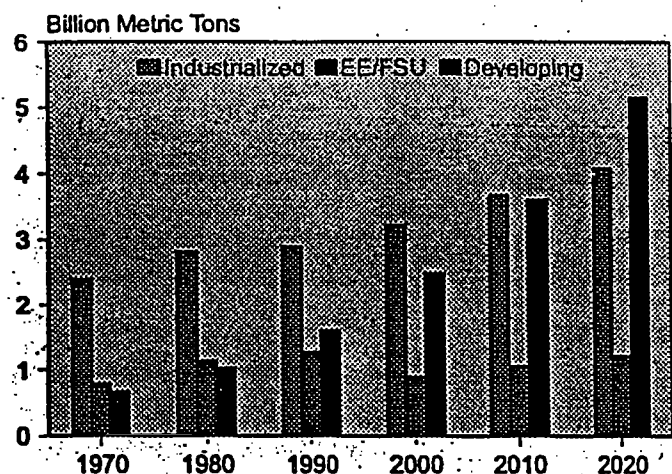


Sources: 1990: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

By 2010, carbon emissions from the developing countries are expected nearly to equal those in the industrialized world (Figure 22). Developing countries will, by that time, consume about 40 percent more coal but only about two-thirds as much oil and natural gas as are consumed in the industrialized countries. But by 2020, the developing countries are expected to consume 95 percent as much oil as the industrialized countries; 74 percent as much gas, and more than twice as much coal. Indeed, if energy consumption in the developing economies approaches the levels projected in the *IEO98* reference case, they will emit 5.2 billion metric tons of carbon, an amount nearly equal to total world carbon emissions in 1990.

In the *IEO98* reference case projections, developing Asia accounts for more than half the increment in world

Figure 22. World Carbon Emissions by Region, 1970-2020



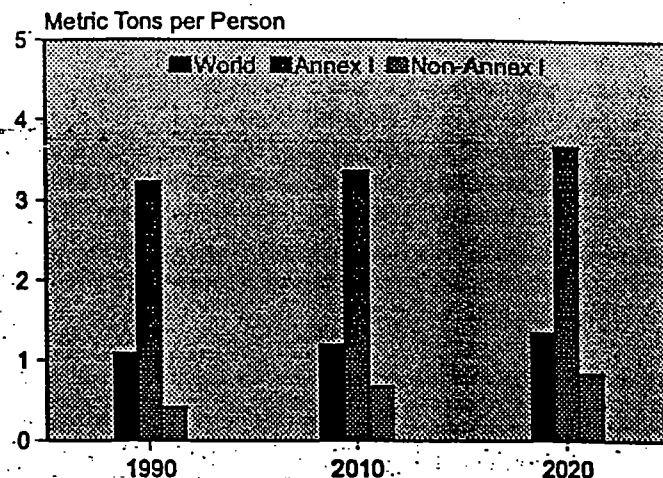
Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Statistics Database* and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

carbon emissions between 1990 and 2020 and three-fourths of the increment for all the developing countries. The increase reflects the region's continuing heavy reliance on coal, the most carbon-intensive of the fossil fuels. Increased coal use accounts for 1.7 billion metric tons of developing Asia's 2.8 billion metric ton increment in carbon emissions. At the end of the forecast period, emissions in China alone surpass those of the United States.

Worldwide, carbon emissions per person grow from 1.1 metric tons in 1990 to 1.2 metric tons in 2010 and to 1.4 metric tons in 2020 (Figure 23). Per capita carbon emissions for the Annex I countries remain markedly higher than those for other countries throughout the forecast period, increasing from a 1990 level of 3.2 metric tons of carbon per person in 1990 to 3.7 metric tons per person in 2020. In comparison, the 1990 level for non-Annex I countries was 0.4 metric tons per person, and the projected 2020 level of 0.8 metric tons is one-fourth the 1990 level of per capita emissions for the Annex I countries. On the other hand, the increments for the Annex I and non-Annex I countries over the forecast period are actually equivalent. The non-Annex I countries accounted for 75 percent of the world's population in 1990; in 2020 they will account for almost 82 percent of the world's population; therefore, the effects of relatively small increases in per capita emissions for non-Annex I countries on overall emissions levels will be far greater than the effects of equivalent per capita increases for the Annex I countries.

Within the Annex I countries, the United States and Canada have the highest per capita emissions levels

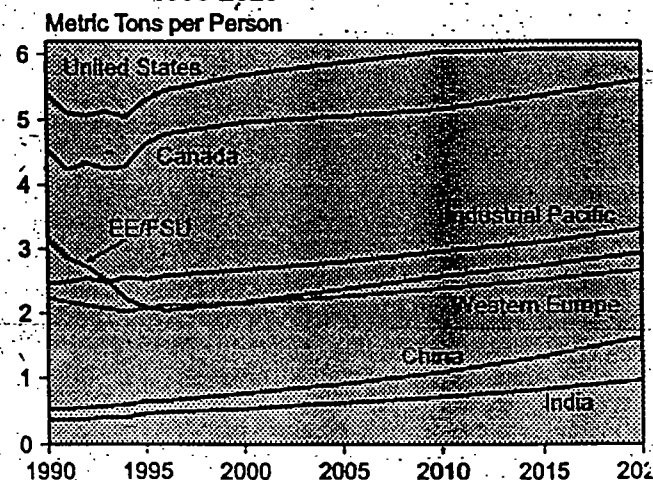
Figure 23. Carbon Emissions per Capita by Region, 1990, 2010, and 2020



Sources: 1990: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

throughout the forecast, reaching 6.1 and 5.6 metric tons per person in 2020, respectively (Figure 24). However, the growth rate of per capita emissions in both countries is projected to be fairly flat after 2000. In contrast, outside the Annex I countries, per capita emissions are projected to increase more rapidly. In China, for instance, per capita carbon emissions in 2020 are projected to be more than triple their 1990 level, reflecting fast-paced industrialization based largely on fossil fuel consumption over the forecast period.

Figure 24. Carbon Emissions per Capita for Selected Regions and Countries, 1990-2020



Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

Bank, and national governments helped finance the project.

Algeria has also been renovating its LNG plants at Bethiou, Arzew, and Skikda, which were constructed in the early 1970s with a combined capacity of about 1,094 billion cubic feet per year. Subsequent work on the project has increased capacity to 1,200 billion cubic feet per year. There are 11 existing contracts for 911 billion cubic feet of Algeria's LNG, with more than one-third of the contracted gas to be delivered to Gaz de France [35, p. 69].

In Nigeria, major efforts have been undertaken to end gas flaring in the country's oil fields. Shell Petroleum Development Corporation of Nigeria (SPDC) has planned four gas-gathering projects to collect gas for Nigeria's Escravos-Lagos Pipe Network to use in various power plants and industrial applications in Odidi, South Forcados, Escravos, and the Greater Ughelli area of Delta State [39]. The Odidi project alone is expected to cost \$250 million and will be used to collect some 80 million cubic feet of gas per day [40].

Chevron and the Nigerian National Petroleum Corporation initiated the Escravos Gas Project to reduce flaring and to recover the gas and condensate from Chevron's offshore oil fields [41]. By September 1997, the project was producing 145 million cubic feet of gas, which was sold to the Nigerian Gas Company for industrial end users. The project also produces 8,000 barrels of liquefied petroleum gas and natural gas liquids per day. Recently, however, funding problems have forced Chevron to delay work on the second phase of the Escravos project, which was to expand the gas gathering system so that another 120 million cubic feet of gas per day could have been processed [42].

Nigeria has plans to develop a natural gas network for domestic consumption, using \$50 million in funding from the World Bank [35, pp. 124-125]. In addition, a number of export projects are either under consideration or already under construction, including plans to develop the \$260 million West African Gas Pipeline Project to provide Nigerian gas for electricity generation and for industrial customers in Ghana, Benin, and Togo [43]. Ghana is expected to consume about 75 percent of the gas from the pipeline at a proposed 300- to 400-megawatt gas-fired power plant at Takadi and at the Valco aluminum smelting plant.

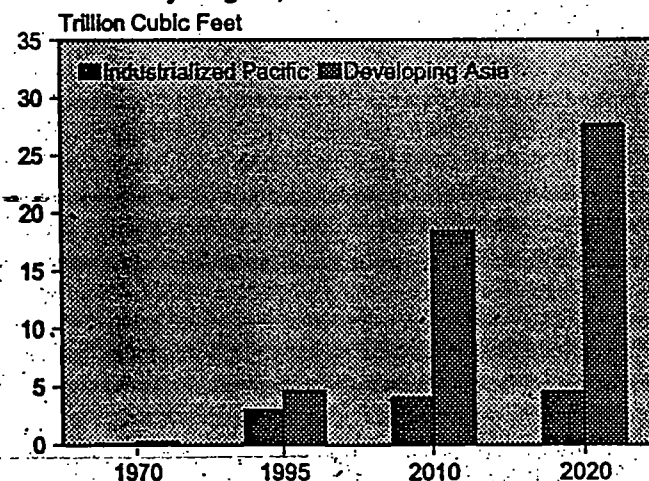
Although several African LNG projects to supply Europe and the United States have been under consideration for years, the Nigerian Bonny LNG project is farthest advanced. With a cost estimated at around \$4.5 billion, the project consists of gas transmission systems, two liquefaction trains, and export infrastructure with a capacity of 254 billion cubic feet. It is scheduled to be

completed by 1999, with first scheduled deliveries to begin in 2000. Agreements for the LNG have been arranged with Spain's Enagas (56 billion cubic feet per year); Turkey's Botas (32 billion cubic feet per year); and France's Gaz de France (18 billion cubic feet per year). Italy's Enel pulled out of an agreement to purchase 124 billion cubic feet per year—by far the largest share of Bonny LNG output—in December 1996 because of difficulties the utility was having in securing an LNG reception terminal. The dispute was resolved in October 1997 when Gaz de France offered to accept Italy's delivery at the Montoir LNG terminal in Brittany [44].

Asia

The 1997 Asian currency crisis resulted in the delay of many energy projects in developing Asia. Nevertheless, many natural gas projects in this part of the world are going forward, although some of the more expensive gas projects, such as the Natuna gas pipeline project and the Omani LNG project, face delays. The IEO98 forecast does not expect a long-term slowdown of economic growth in the region. In developing Asia, natural gas consumption is projected to grow nearly sixfold over the 25-year period, from 4.7 trillion cubic feet in 1995 to 27.7 trillion cubic feet by 2020. In industrialized Asia (Australia, Japan, and New Zealand) gas use grows at a more conservative pace of 1.6 percent annually, from 3.1 trillion cubic feet in 1995 to 4.6 trillion cubic feet in 2020 (Figure 54).

Figure 54. Natural Gas Consumption in Asia by Region, 1970-2020



Sources: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and *International Energy Annual 1996*, DOE/EIA-0219(96) (Washington, DC, February 1998). Projections: EIA, World Energy Projection System (1998).

Thailand was hit particularly hard by the economic downturn. The economic recession has meant that many energy projects in the country are being renegotiated. The 50-percent devaluation of the Thai baht between

May and October 1997 led to a postponement of a number of gas projects. Oman LNG announced that both the Petroleum Authority of Thailand (PTT) and Oman LNG had agreed to suspend the unsigned 25-year LNG agreement that would have brought 1 million tons of LNG per year to Thailand beginning in 2001, rising to 1.7 million tons in 2003 and 2.2 million in 2004 [45]. The PTT had wished to delay taking the Oman LNG by 10 years, because projections for gas demand for the next decade have been cut by 20 percent [46].

A project designed to pipe natural gas from Indonesia's Natuna gas field in the South China Sea also faces delay and renegotiation since Thailand's economic downturn. Indonesia's state-owned Pertamina negotiated a 2-year delay for PTT's purchase of Natuna gas, moving the startup date for the contract from 2003 to 2005 [47]. Moreover, price negotiations are expected to delay deliveries another 2 years, so that the first Natuna gas would be delivered to Thailand in 2007. PTT wanted to renegotiate the price of Natuna gas from the original terms to a price below that of gas from the Malaysia-Thailand Joint Development Area; however, Pertamina would not agree. Originally, Thailand was to begin purchasing 500 million cubic feet per day from the Natuna project, increasing to 1 billion cubic feet per day after 2 years.

Despite the cuts, a number of natural gas projects are going forward, and a substantial number of companies still are interested in working on gas projects in Thailand. Unocal corporation announced in mid-November 1997 that it expected development on the first phase of its Pailin field—with production of 165 million cubic feet per day scheduled to begin at the end of 1998—to continue on schedule [48]. Moreover, in October, the U.S. energy company Enron signed a partnership with a Thai engineering company, EMC, to "pursue investment opportunities in infrastructure projects" in Thailand that will include natural gas pipelines and electric power plants [49]. The Canadian natural gas company, Nova Corporation, announced in November that it had an interest in participating in construction of gas pipelines and electric power plants in Thailand, in particular a third natural gas trunk line planned for the Gulf of Thailand [50].

PTT also signed an agreement in November to purchase gas from two fields in the Gulf of Thailand from Rutherford-Moran Oil Corporation [51]. The corporation already supplies PTT with 100 million cubic feet per day of gas. The new agreements will increase that amount to 300 million cubic feet per day when production at the two gas fields begins at the end of 1999.

Malaysia continued some aggressive gas development in 1997. There is concern that the country might face power shortages in the long term, accentuated by the

indefinite postponement of the large-scale Bakun hydroelectric project earlier in the year in response to a combination of environmental criticism and the Asian economic crisis. As a result, Malaysia has decided to increase its gas-fired power generation capacity [52]. Malaysia has committed to accept delivery of 300 million cubic feet per day of the first production from the Malaysia-Thailand Joint Development Area (JDA), which should begin operating in late 1999. Because it will take time for the electricity generating infrastructure to catch up with the gas production, much of the first gas is expected to be used by a proposed petrochemical plant.

Exploration in the JDA has been quite successful, with 10 trillion cubic feet of gas already discovered. Malaysia's Petronas and U.S. Triton Energy (forming the joint venture, Malaysia-Thailand Joint Authority—MTJA) believe another 10 trillion cubic feet of gas could be discovered [52]. In fact, in November 1997, the MTJA confirmed the discovery of an eighth field in the JDA, called Wira-1, with a gas flow of 9.1 million cubic feet per day. Four other finds were made in 1997 alone.

Pakistan is attempting to expand its natural gas consumption, which already accounts for almost 40 percent of its primary energy consumption [21, pp. 180, 186]. The country currently produces virtually all its own gas, but consumption is expected to overtake production soon, and efforts have been made to secure supplies from outside sources. In 1997, Unocal announced that Pakistan would be linked to Turkmenistan in a Central Asia Gas Pipeline project [53]. The 790-mile pipeline would deliver up to 2 billion cubic feet per day of natural gas from southeastern Turkmenistan's border to Multan, Pakistan, with a guarantee that up to 25 trillion cubic feet of gas could be supplied through the pipeline from the country's Dauletabad field. The consortium of six companies and the Turkmenistan government are also considering adding a 400-mile extension to the pipeline, which would take gas to New Delhi, India, as well.

India is in the process of developing its import, transmission, and distribution grid to allow gas to penetrate major cities more rapidly. In an attempt to attract foreign investment in the natural gas sector, shares of the state-owned Gas Authority of India Limited (GAIL) were placed on the Bombay Stock Exchange in May 1997 [54]. GAIL was actually formed only 13 years ago. The company manages India's only major gas pipeline, the HBJ, which is used to deliver gas from the Bombay High field and other offshore fields to the cities of Hazira, Bijaipur, and Jagdishpur, as well as other northwest Indian cities. Most of the gas moved by HBJ is used at large electric power plants and for fertilizer plants, but the government would like to increase residential and small commercial use.

Notes on Current Events in Chinese Energy Supply and Potential Impacts on the Five-Year Plan

Into the third year of the Five-Year Plan, there are reports that several regions are experiencing surpluses of electricity. Authorities have publicly indicated that isolated instances of excess electricity generation capacity will not cause significant changes to the Five-Year Plan goals for the electricity sector. (See attached, classified cables 98 Beijing 6415 and 98 Beijing 3808 for Embassy reporting on this issue.)

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NO.062 P.3

Status Of China's Power Sector

Since 1990 China has added an average of 15 GW annually and total installed electricity generating capacity reached 250 GW in 1997, according to official statistics. In addition, China's demand for electric power has slowed along with economic growth. China's economic growth has slowed from 10.3 percent in 1995 to 9.7 percent in 1996 and 8.8 percent last year, according to official Chinese statistics. In addition, state-owned enterprise reform by closing inefficient factories may have suppressed demand particularly in northern areas of China. State Development and Planning Commission Officials had anticipated electricity consumption would increase by 6 percent annually from 1996 to 2000, but the annual increase in consumption averaged only about 4-5 percent in the past two years, according to diplomatic reports. Electricity demand from heavy industry--which consumes 59 percent of China's electricity consumption--has fallen due to production cutbacks and closures as state enterprises restructure, according to diplomatic reporting. (U)

DATE: 22 April 1998

TO: Mario Merida, State Department,
Phone: (202) 647-2231
Fax: (202) 647-4037

FROM: Edward Jackman, OTI/ESG/EDT
Phone: (703) 482-9102

RE: China's Easing Electricity Shortages Have Minimal Impact On Its Five-Year Plan (U)

China's easing of electricity shortages is likely to have little impact on the current Five-Year plan. Chinese press call the easing of electricity shortages a temporary condition, requiring continued efforts to adjust the power industry's structure. Although most key industrial and population centers in China are experiencing excess electricity generation capacity, most regions of China remain unable to meet peak demand needs. In rural and western parts of China between 60 and 100 million Chinese remain without power. Moreover, Beijing remains committed to its goal of installing an additional 40 gigawatts (GW) of capacity over the next few years to reach a total of 290 GW by 2000, according to press reports.

- Conditions of excess electricity generation capacity in some regions of China may persist for two to five years, depending on economic growth, new capacity additions, and grid improvements, according to diplomatic reporting.
- The lack of connectivity between China's five regional power networks, eight independent provincial networks and two autonomous region networks has resulted in an uneven distribution of electricity within China. (U)

Under the current Five-Year plan Beijing stressed grid connectivity and expansion--the importance of this has likely become only more apparent under current conditions. In addition, the plan also called for the substitution of new large-scale coal-fired power generators for old inefficient small-scale coal-fired plants and this is likely to be implemented with more vigor; however, progress in this remains unclear.

- Significant power sharing between grids is unlikely until around 2010 when current plans call for the establishment three regional grids centered around the Three Gorges Dam.
- Beijing has called for the closing of 10 GW of small coal-fired plants over the next three years, according to press reports. (U)

Notes on Hydro and Nuclear Electricity in China

China's electricity generating capacity has reached 250 gigawatts, according to official statistics. Total electricity production is expected to increase by 18 gigawatts with completion of the Three Gorges Dam in 2009. The project, however, has been criticized because it will displace more than one million people and threaten wildlife. The US maintains a neutral position on China's decision to proceed with construction on the Three Gorges Dam, and there are no restrictions on US company participation in the project, although EX-IM Bank financing is not available for this purpose. US companies are involved in the project, based in part on non-American financing, and US-made equipment is evident at the Three Gorges Dam construction site. China currently has two operating nuclear plants and plans for another nine. Together, these plants would add another 8 gigawatts to national generation capacity. In 1998, President Clinton opened the door for US participation in these projects by certifying that China met the requirements necessary for implementation of the 1985 Agreement on the Peaceful Uses of Nuclear Energy. The 30-day congressional review of certification ended in March, setting the stage for US vendors to apply for licenses for nuclear power exports to China.

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What is U.S. Policy?

The U.S. maintains a neutral position on China's decision to proceed with construction of the Three Gorges Dam, and there are no restrictions on U.S. company participation in the project. U.S. companies are involved in the project, based in part on non-American financing, and U.S.-made equipment is evident at the Three Gorges Dam construction site.

THREE GORGES DAM PROJECT

Background

China has begun construction of the massive Three Gorges Dam on the Yangtze River in Hubei Province. When completed in 2009, its 18,200 megawatt capacity will make it the largest hydroelectric project in the world. Diversion of the river occurred in November, 1997, after which construction of the two-kilometer dam proceeded. The project is expected to cost at least \$25 billion. Former Premier Li Peng, an electric power engineer by training, championed this project through years of sometimes bitter domestic debate. The Chinese government believes that in addition to providing renewable energy, the dam will improve river navigation and control periodic flooding of the lower Yangtze River, saving thousands of lives and reducing property losses. However, the project has drawn criticism because of its potentially serious adverse environmental impact, and some international experts question whether it can achieve its goals.

The U.S. worked intermittently with China on hydroelectric development from the 1940s until 1993. The U.S. Bureau of Reclamation was involved in the initial design of the Three Gorges project, but halted its cooperation in 1993 because of changing U.S. attitudes and policies on water resource management and environmental concerns. In September 1995, the National Security Council recommended that the U.S. government refrain from providing financial support for the project due to continuing environmental, legal, financial and humanitarian concerns, including the involuntary resettlement of the over one million people who would be displaced by the project's reservoir.

In May, 1996, the Board of the U.S. Export-Import Bank withheld Letters of Interest to three U.S. exporters based on its independent review of the environmental effects of the project. By statute, the Bank may withhold project financing because of adverse environmental effects. China contended it was addressing environmental concerns, but Ex-Im concluded it did not have enough information on questions relating to water quality of the reservoir, protection of ecological resources - including rare and endangered species - and the environmental and socioeconomic impact of the resettlement project. At the request of the Three Gorges Power Development Corporation, in July, 1996, Ex-Im Bank sent a letter detailing the environmental information it would need to be able to address its concerns. The information it requested is similar in nature to that required of any major hydroelectric plant. The Bank periodically receives additional environmental information, but this data has not completely addressed its concerns. Ex-Im Bank stands ready to review information which would address the points set forth in its July, 1996, letter. Other nations, including every other G-7 member country, have provided financing for the Three Gorges project. However, the World Bank and Asian Development Bank have not provided funding for the project because of environmental and technical concerns.

The first large procurement of electromechanical equipment was awarded in August, 1997, to consortia consisting of various European, Canadian and Japanese suppliers. In October, 1996, one U.S. company was awarded a contract for construction equipment without Ex-Im Bank financing.

Notes on Coal Use in China

China's reliance on coal comes at a high environmental price. Current SO₂ emissions in China exceed 16 million tons per year. The World Bank projects these emissions will grow to 27 million tons by the year 2000, and to 55 million in 2020. Coals burning contributes 92 percent of SO₂, 70 percent of NO_x, and 70 percent of particulate emissions in the country. Coal combustion from residential space heating is the primary cause of worsening urban air pollution. China has elevated its interest in addressing environmental problems, with a particular focus on local air and water pollution problems.

China emerging as bad boy in pollution stakes

Rampant growth and heavy dependence on coal make China a villain in environmentalist eyes, writes James Harding

The urban pollution figures for China are enough to make you want to leave the country: 178,000 people die each year because of pollution; the blood-lead levels of children in Shanghai and other large cities average 80 per cent higher than those considered safe for mental development; and the levels of total suspended particles and sulphur dioxide are two to five times World Health Organisation guidelines.

As China's economy has soared ahead at double digit growth rates in recent years, the volume of pollutants pumped into the atmosphere has soared, creating a range of health risks and threatening to export huge environmental problems beyond Chinese borders.

Just as quickly the Chinese leadership has become keenly sensitive to environmental concerns, if the rhetoric and new regulations are a measure. The problem has been how to enforce the new environmental protection laws on the ranks of China's troubled and ageing state-owned industries.

At an international level - as delegates this week to the Kyoto summit on climate change can testify - the challenge is to get China to sign up to binding global commitments while respecting the country's right to pursue its agenda for economic development.

China discharges 14 per

cent of the world's greenhouse gases, the largest contributor to global warming after the US, which is responsible for 22 per cent.

The overwhelming reliance in China on coal-fired energy is one of the chief sources of air pollution, one that has got worse as an expanding economy has driven energy demand. Coal use has more than doubled since 1980, reaching 1.3bn tonnes in 1995.

The World Bank calculates that if Chinese industry and energy consumption continues to grow in line with official forecasts - and without a proactive set of national



and international policies to address environmental damage - carbon dioxide emissions will produce 2,380m tonnes of carbon in 2020, nearly three times the 800m tonnes in 1995.

With climate change models predicting an increase in the earth's surface temperature of 1 to 3.5 degrees Celsius by 2100 and sea levels rising by 15 to 95 centimetres as a result, China is acutely aware that it may suffer devastating effects itself.

Increased greenhouse gas levels will raise temperatures and cause more frequent storms, which would lower rice, wheat and cotton

production. A rising sea level would threaten tens of millions of people living in low-lying areas - according to one Chinese study, a one metre rise could endanger an area the size of Portugal, threatening to flood cities such as Shanghai and Guangzhou, and displacing 67m people.

Like politicians elsewhere, Chinese leaders in the 1990s have been quick to see the political kudos in championing the environment. Song Jian, a member of the State Council, China's cabinet, for example, recently reaffirmed Beijing's commitment to protecting the environment.

A torrent of new regulations and international conventions has accompanied this rhetoric - over the last five years, the Chinese government has issued more than 110 environmental rules and laws and signed up to 10 international treaties on the environment.

But government officials privately admit that China fails to meet its own standards.

"Regulatory enforcement has been the weak link in China's system," says the World Bank, citing the patchy record of local authority enforcement. "Local governments face a trade-off between protecting the environment and safeguarding the financial and employment performance of local firms."

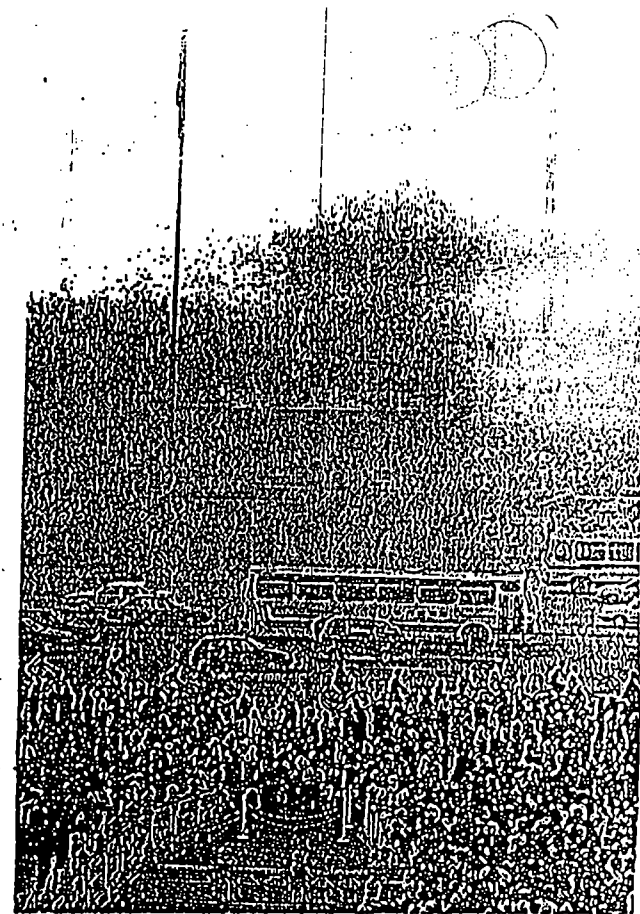
Future environmental

measures will also have to go beyond the control measures of the past, the Bank argues. It suggests that China must harness market forces to work for the environment, using taxation to punish pollution, and it must commit higher levels of investment to clean and efficient technologies - pollution control investments will have to double to about 1 per cent of gross domestic product.

The Kyoto summit has offered a reminder of the diplomatic wrangles that dog environmental protection. China counts itself among the developing countries, which have threatened to reject US demands for binding commitments to cut greenhouse gases, arguing that they should not be required to sacrifice their development, but that richer countries can afford to take on the bulk of the costs associated with controlling emissions.

Liu Bin, associate professor of urban ecology and environment economics at the Institute of National Economy, says: "The Chinese government - and the developing countries in general - always say that developed countries should have to shoulder the responsibilities to help developing countries combat environmental damage. This can be done by way of transfer of environmental technologies."

China is the largest recipi-



Murky outlook: Pollution clouds Beijing's Tiananmen Square during National Day in October

Photograph

ent of funds from the Global Environment Facility, the international financial organisation managed by the UN and the World Bank to support global environment projects, which has provided \$170m in grants for operations in China since 1995.

The regional evidence in China so far suggests that economic development, which has resulted in greater industrial output and higher emission levels, may ultimately help improve China's environmental record. A study of 50 cities in China shows that as wages rise, the pollution density of suspended particles falls - a

symptom of tougher enforcement of regulations in richer areas as well as more inefficient production in poorer areas.

On a comparative basis in China, then, Shanghai, where the economy has been growing at an average rate of 14 per cent in recent years, may not prove to be such a bad place to live after all.

*Clear Water, Blue Skies - China's Environment in the New Century, World Bank China 2020 series.

This is the fifth in a series of articles on issues facing the Kyoto climate change conference

Who Will Fuel China?

Thomas E. Drennen and Jon D. Erickson

Throughout this decade, China's real gross domestic product (GDP) has grown an average of over 11% each year. Although the recent economic troubles in Asia may dampen this trend, the likelihood for strong long-term growth raises serious questions about energy import requirements and the global environment. To help fuel her unprecedented growth, in 1993 China became a net importer of oil for the first time in history. In 1997, her average net imports were 800 thousand barrels per day, twice the 1995 levels (1). The impact of China's total fossil fuel consumption also dominates the politics of global environmental change. Any climate protection resulting from the greenhouse gas treaty negotiated in Kyoto, Japan, and opening for signature at the United Nations on 16 March, will depend on the future of Chinese emissions.

Chinese oil imports could reach 7 to 8 million barrels (mbbl) per day by 2015, and 13 to 15 mbbl per day by 2025 (2). In comparison, the United States currently imports 8.4 mbbl per day. A large share of current Chinese imports come from the Persian Gulf. Together with projected global declines in oil production in 20 years (3), these demands on the global oil market pose a serious threat to future global energy security.

To limit dependence on oil imports, the Chinese government has embarked on two main supply-side strategies: development of domestic oil supplies and substitution of other fuels for oil. For the first, China hopes to attract foreign investment to develop remote sites in western China, most notably the Tarim oil basin. Initial exploration efforts, however, have been disappointing. As of July 1996, the Department of Energy reports that just 4 billion barrels of oil reserves have been verified at the Tarim basin (current global consumption is 25 billion barrels per year) (4). The second strategy has largely translated into aggressive domestic coal production. China's current Five-Year Plan projects domestic coal production of

1400 million tons by the year 2000 (5). Nevertheless, given the necessity of oil in many current industries, the current and projected large share of industrial sector GDP (42% in 1995), and a growing transportation sector, substitution of coal is projected to have a limited impact on the need to import oil.

On the demand-side, inefficiency has been the norm. In 1994, China reimposed central control over the domestic oil market through price fixing and channeling all sales through state agencies (6). This reversal of prior market reforms is partly responsible for excess demand in oil and the need for increased imports.

Other options to fuel China's development include hydroelectric and nuclear power. In 1995, hydroelectricity accounted for ~20% of China's electricity generation; China's three operating nuclear power plants accounted for less than 1%. China has launched an aggressive hydroelectric program that includes construction of what will be the world's largest dam, the Three Gorges Dam on the Yangtze River. Hydroelectric capacity is forecast to increase from 32 gigawatts in 1990 to 138 gigawatts in 2020. Official plans foresee installed nuclear capacity increasing from the current 2.1 gigawatts to 30 to 40 gigawatts by 2020 (7). Assuming foreign investment will rise to meet these optimistic scenarios, and considerable environmental challenges of hydro and nuclear development can be overcome, future hydro and nuclear development would account for less than 6% of primary energy needs by 2025. The share of relatively expensive non-hydro-renewable energy is expected to be even less. Total energy supply from these technologies, such as solar thermal, photovoltaic, geothermal, and wind power currently account for less than 1% of China's commercial energy supply. Without significantly altering its energy structure, the bulk of China's 2025 primary energy supply will be coal (68%) and oil (25%).

With respect to future greenhouse gas emissions, assuming aggressive nuclear and hydro development and substantial declines in industrial energy intensity (energy per unit GDP), CO₂ emissions from energy use are projected to increase from 0.7 billion tons today to 2.1 billion tons by 2015 and to 3.2 billion tons carbon by 2025. This com-

pare to current global CO₂ emissions of 6.15 billion tons carbon. Complicating the negotiation process is China's inherent right to develop. A measure of development and fairness in past negotiations has been the distribution of emissions on a per capita basis (8). Under CO₂ and population projections, China would increase per capita emission from a current 0.6 tons to 2.2 tons by 2025. Despite this growth, the nearly three-decade projection is still only half the current per capita emissions of the United States.

Thus, for the foreseeable future, China has little incentive to participate in any agreement seen as limiting their right to economic growth. The Kyoto Protocol only sets greenhouse gas targets for current industrialized nations. However, continued growth in energy demand in China in particular, and developing countries in general, will more than offset emission reductions mandated by the Protocol.

As developed countries consider options for meeting the obligations of reducing emissions in accordance with the Kyoto Protocol, they must confront the implications of continued growth in energy demand in the rest of the world and particularly in China. Effectively limiting total global emissions will thus require a sustained international commitment to improving global energy efficiency and expanding research into and use of non-carbon emitting energy technologies. Reducing emissions in developed countries, coupled with less carbon-intensive economic growth in developing countries, comes closest to achieving meaningful climate policy goals. An ancillary benefit would come through reduced pressures on the global oil market. In the interim, committing to emissions targets reached by developed countries in Kyoto is a first step toward eliciting the essential cooperation of China and other developing countries and protecting our common future.

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Background Notes: The Energy Dimension of Climate Change in China

China is the world's second highest emitter of energy-related carbon dioxide. According to the US Department of Energy, Energy Information Administration (DOE/EIA), China's energy-related emissions of carbon were almost 805 million metric tons (mmt) in 1996 -- roughly accounting for 13 percent of all global energy-related emissions of that greenhouse gas. (In comparison, the US emitted some 1466 mmt of energy-related carbon, or about 24 percent of the global total.) As China's population and economy have continued to grow, so too have its carbon emissions: from 1987 to 1996, its energy-related emissions grew by about 40 percent. Chinese industrial activity (including electricity generation) has historically accounted for 75 percent of China's energy consumption and the largest share of the country's energy-related carbon emissions. The OECD/International Energy Agency reports that in 1995, carbon emissions from manufacturing and construction accounted for over 45 percent of national totals, due largely to direct fuel (principally coal) burning. Public electricity and heat production that year accounted for about 33 percent of energy-related carbon emissions, and transportation (including international aviation) accounted for just under 6 percent of the country's energy-related totals.

Carbon-intensive, but domestically plentiful coal is the principal culprit of China's high carbon emissions. According to the IEA, in 1995 coal accounted for almost 85% of China's total carbon emissions. *(See Tab 1 for additional information on the environmental impact of coal use in China.)* Coal was used to produce about 75 percent of electricity production, hydro for about 20 percent, and natural gas and nuclear, together, for the remaining 5 percent. (In 2015, coal is projected to retain its importance in China's fuel mix, increasing its share to 77.4 percent. At the same time, the shares of hydroelectricity, natural gas and nuclear are expected to increase, and that of petroleum to decline.) USDOE reports that in 1995, coal accounted for 74.5 percent of China's primary energy production. That same year, petroleum accounted for 18.1 percent, hydroelectricity 5.1 percent, natural gas 1.9 percent, and nuclear power 0.4 percent of total primary energy production. *(See Tab 2 for additional background on hydro -- including Three Gorges -- and nuclear issues.)*

China's Ninth Five-Year Plan (1996-2000) looks to the energy sector and related industries to strengthen their ability to support national economic growth. The plan calls for total energy output to increase by 9 percent by 2000 -- a production increase heavily dependent on coal, in addition to enhanced production of oil and natural gas. The plan seeks to "rationalize" energy prices, promote energy conservation and increased use of renewables, and improve other energy infrastructure and distribution facilities.

Based on anecdotal evidence and non-official reports, in "rationalizing" energy prices, authorities are building on energy conservation efforts which in 1994 included the freeing of coal prices. More recently, and as part of the current Five-Year Plan, China has increased gasoline prices -- setting them above current world market levels.

Electricity tariffs have also undergone some reform: in order to attract foreign investment in new power plants, industry press reports tariff controls have been eliminated for electricity sales by foreign-built or financed facilities (although the Ministry of Electric Power Industry has reportedly set a de facto limit of about 15 percent on the internal rate of return -- and indirectly, the tariff -- for such foreign ventures).

Under the Plan, authorities have targeted the electric power generation sector with annual increases of capacity and output of 7 percent. Electric power is to be increased by more than 80 gigawatts of production capacity in order to reach 290-300 gigawatts at the end of the Plan period. (In 1995, China's electricity generation capacity was estimate at 190 gigawatts. Official statistics now place it at 250 gigawatts.) This increased potential is aimed at meeting climbing electricity demand (projected to increase by six percent per year) and supplying the up-to-100 million people who were without access to electricity services in 1996. (*See Tab 3 for discussion of current energy supply issues and the Five-Year Plan.*) The Plan includes simultaneous promotion of hydro and thermal sources, "appropriate" development of additional nuclear plants, power stations near coal mines, and alternative energy sources including wind, marine energy, and geothermal power. A DOE team recently visiting Chinese renewable energy sites concluded that "the pace of renewable energy deployment is accelerating."

Although China's energy consumption per unit of output has been cut nearly in half since 1970, the country's major industries, including electric power generation, continue to use energy far more intensively than in developed and most developing countries. Another important goal of the current Five-Year Plan is aimed at addressing this energy issue, mandating energy efficiency improvement of 5 percent annually throughout the period. (Using a fossil fuel use/yuan GDP measurement, China's energy efficiency improved by an averaged of about 5.9 percent per year from 1990 to 1995.) The iron and steel, nonferrous metals, chemicals, building materials, and transportation industries are targeted for efficiency efforts. In the electricity generation sector, Chinese plans to use higher-efficiency generators would also serve to reduce the growth of energy demand -- and ultimately the growth of carbon emissions. A recently passed energy conservation law, which requires all levels of government to consider energy-efficiency goals in the approval process for all infrastructure and industrial projects, may further bolster the energy-efficiency goals of the current Five-Year Plan. (We are looking at ways of assisting China in its efforts to address environmental consequences of fossil fuel consumption through the US-China Energy and Environment Cooperative Initiative signed in late 1997. In this regard, USDOE has recently offered technical assistance to China to implement its new energy conservation law.)



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TAGS: ENRG, ECON, EFIN, EINV, ETRD, EIND, CH

SUBJECT: CHINA'S ELECTRICITY SURPLUS: REAL BUT
TEMPORARY

REF: Beijing 3357

(U) Sensitive but unclassified, handle accordingly.

BEIJING 01 OF 05 3808

1. (SBU) Summary. Discussions with a wide range of U.S. firms involved in China's electric power sector have continued to elicit the same consistent response: China is experiencing an overall electricity surplus that could last two to five years (reftel). Statements in the Chinese press and from Chinese officials also indicate that an overall surplus exists, and the Ministry of Electric Power (MOEP) has revised its five-year plan as a result. Statistics showing the growing reliability of electric supply appear consistent with this trend, while a slowdown of heavy industry and improved reliability of power plants are important contributing factors. China has significant pockets of unused capacity and great room for increased efficiency, additional factors that could partially offset future growth in demand. The country's long-term economic growth, however, will

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require continued growth in the power industry over the longer term. As these projects go forward, U.S. firms are concerned that large World Bank loans to specific projects displace foreign financiers and distort the power market. End summary.

Range of U.S. Firms Consistently Cite Surplus

2. (SBU) Economic and Commercial officers have continued to discuss China's electric supply situation with a broad range of U.S. firms involved in China's electric power sector (in addition to those in reftel). The views expressed consistently concluded that such a surplus exists and would probably persist for the near-term -- ie., two to five years -- depending upon overall economic conditions. Our Australian Embassy counterparts have also concluded that such a surplus exists.

Chinese Press Acknowledges Situation

3. (U) A variety of Chinese press reports support a power surplus at this time. For example, a wrapup piece on China's 1997 energy industry published in January by the official news service, Xinhua, stated that "By 1997, overall supply and demand for our country's energy industry eased, and the industry started to change from a seller's market into a buyer's market...sever power shortages ended in 1997...by the end of 1997...the national economy's [electricity] needs were basically fulfilled. At present the conflict in energy supply and demand has eased, and we basically solved the problem of serious power shortage in most areas, with supply outstripping demand in some. The speed of electric power development in our country, which was mainly dictated by investment size in the past, became increasingly dictated by market demand, and the electric power market's switch from a seller's market to a buyer's market gradually took place."

4. (U) Other examples include a long article this week in the China Electric Power News. The article, discussing the electricity surplus in Guizhou Province, began with the following paragraph (informal translation): "Since 1997, the Guizhou electric power market has been the same as that of the country; there has appeared a phenomenon of supply and demand balance, with supply even exceeding demand." The article goes on

BEIJING 02 OF 05 3808

5. (U) An additional manifestation of the satisfactory supply has been the near disappearance of previously common power outages. According to the China Electric Power Newspaper, during the first three quarters of 1997, the reliability of the electricity supply to average users in 206 cities had reached 99.698 percent -- a 0.64 percentage point rise over the same period in 1996.

MOEP To Adjust 9th Five-Year Plan

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(U) According a 22 February announcement in the paper, the Ministry of Electric Power has recently announced it will revise its plans for the final three years of the Ninth five-year plan. While the article provided only general statements regarding the revisions, it stressed cutting unnecessary investments and carrying out detailed analysis to ensure that demand and supply were in conformity when considering future investment. The article was titled, "Raising the Electric Power Industry's Quality of Growth."

Chinese Officials Acknowledge Adjusting for Surplus

7. (SBU) An analyst in the State Planning Commission's Communication and Energy Department told Econoff this week that electricity supply and demand were now matched in many places. While noting that some shortfalls still occurred during peak usage hours in some areas -- especially in the northeast -- he acknowledged that an overall surplus existed. Responding to a question, he said the power plant running time averaged under 4,000 hours in eastern China south of Beijing, and over 5,000 hours per year to the northeast. In both regions, however, he said the average hours of operation had dropped from 1996 to 1997.

8. (SBU) The official explained that during the formulation of the Ninth five-year-plan, officials had projected an annual growth in electricity demand of six percent. Actual growth in the first two years, however, had only been around four to five percent. Consequently, he stated, some projects originally scheduled for the 9th five-year plan would be pushed back.

9. (SBU) An official from the Xishan Coal Electric Group Company told Econoff that coal surpluses in 1997 were largely due to a drop in demand from thermal electric power plants. The official predicted that the situation would continue for two to three years but said everything depended upon the economy.

10. (SBU) Tan Aixing, a Vice Minister in MOEP, told Econoff this week that China faced an electric power surplus. Tan stressed the temporary nature of the surplus, however, noting that the phasing out of old, inefficient state-owned industries who were heavy power users was a one-time windfall for the demand side. Nonetheless, some 10 Gigawatts of installed capacity consisted of very small generating units while another 13 Gigawatts was old and inefficient. These, he concluded, would have to be replaced in the future.

BEIJING 03 OF 05 3808

11. (SBU) Comment: All of these officials also responded to questions regarding changes expected to be approved at the National People's Congress. According to their statements, some 10 percent of the SPC's 1,000 personnel would likely be trimmed, with many moving to the State Economic and Trade Commission (SETC). The SPC itself would likely be renamed the State Development Commission and be removed from the planning role, at least for industrial and energy ministries, and focus on macroeconomic issues. The SETC will begin to administer the vestiges of the industrial ministries. For example,

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the Ministry of Coal will become a bureau under the SETC; the State Power Corporation -- the MOEP's successor -- will also fall under the SETC. One leading rumor states that Vice Premier Wu Bangguo may take up the leadership of the SETC. While they expect Premier Li Peng's change in position to largely remove his influence over the power sector, they state that Zhu Rongji -- who also has some background in the energy sector -- may take as close an interest as his soon-to-be predecessor. End comment.

Heavy Industry: The Big User, the Big Slowdown

12. (U) In examining China's temporary electricity surplus, one key factor to consider is that electric consumption is strongly weighted towards heavy industry -- perhaps the sector suffering the greatest slowdown because of China's overall slowdown in economic growth, State-owned enterprise reform, and the Asian financial crisis. According to the Asian Development Bank, heavy industry accounts for 59 percent of China's electricity consumption, followed by light industry at 15 percent, residential consumers at 11 percent, public and commercial consumers at 7 percent, agriculture at 6 percent, and transportation and telecommunications at 2 percent.

Another Factor: Power Plant Reliability Improving

13. (U) In addition to the the above factor -- and those cited reftel -- is the fact Chinese power plants are increasingly reliable, and thus can supply more hours of electric power annually. Lu Yanchang, Vice Minister of the MOEP recently stated that the reliability of domestically produced power-generating units with capacities of 100 Megawatts or more has risen to 86 percent, a 4.4 percentage point increase since 1992. (Note: 59 percent of China's power is now produced by generating units with capacities of 100 or more megawatts.)

Efficiency Improving, But Major Slack Still Exists

14. (U) Unlike the OECD experience of recent years, there has not been a one-to-one correlation in China between growth in gross domestic product (GDP) and electricity growth. This is partly due to gains China has made in efficiency. China's electric consumption (in kWh) per dollar of GDP (in 1990 dollars) fell from 1.56 in 1985 to 1.49 in 1995, according to World Bank statistics, a drop of 4.7 percent. In OECD countries (excluding the Czech Republic and Hungary) the figure

BEIJING 04 OF 05 3808

More on the World Bank Problem

15. (SBU) Despite the surplus, U.S. firms remain interested in power projects for the long term -- carefully devoting major efforts towards discerning areas of real power shortages. They remain concerned,

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ever, that the major role the World Bank plays in China's power sector displaces U.S. business opportunities. The World Bank has provided financing for 18 power projects in China and has three projects currently pending. One corporation's officer claimed that the World Bank is no longer investing in power projects elsewhere in Asia but that its officers in China are under pressure to continue major funding in China's power sector.

16. (SBU) In the view of some U.S. businesses, the World Bank's efforts to improve social conditions through power project investment are well-intentioned but its assessments of capital availability for Chinese power projects and regions of true power shortfalls are based on outdated studies. As a result, the Bank might be displacing foreign investors who would be willing to finance power projects in areas where shortages exist or where long-term demand is still viable. They claim that the 2 x 900 Megawatt Wugaochao plant in Shanghai could have been financed privately, albeit at more expensive terms.

17. (SBU) The Chinese naturally prefer cheaper World Bank financing. With World Bank loans, power companies set tariffs in contracts at rates lower than the market rate of return that commercial financiers would require. This distorts market conditions as the Chinese, in other projects with commercial financing, cite these low tariff levels as being sufficient for investor returns. Lastly, U.S. businessmen state, the threat of capital flight -- one of their best weapons against widespread contract breaches -- is minimized in the power sector because of the availability of the World Bank financing.

World Bank Responds

18. (SBU) The World Bank's senior representative here, Yukon Huang, told Eminocons that he is unsure of the aggregate supply-demand situation because Chinese data is imprecise. He explained that there do appear to be pockets, especially in central and western China, where demand is not being met. Power deficits, he said, are still common in many low-income, rural areas.

19. (SBU) Huang was very sensitive to questions regarding World Bank displacement of commercial opportunities in the power sector. He explained that the Bank's loans to a power project are usually very small but act as a catalyst to attract other lenders, especially when the Bank brings its expertise to bear on organizing and structuring projects for predominantly

BEIJING 05 OF 05 3808

20. (SBU) He acknowledged that the Wugaochao Shanghai project could be viewed as displacing commercial financing. He said he understood the controversy but that without Chinese government guarantees, available to the World Bank but not to private investors, the project would have been impossible to finance. He admitted that higher interest rates would perhaps have accommodated the higher risk that private investors would have faced.

(SBU) Huang explained that he was new to China,

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having arrived several months ago. He agreed to meet with interested U.S. industry representatives informally at the Embassy to take stock of private sector concerns -- but only after he finalizes a World Bank investment in a power project in Hunan. (Note: We are seeking more information on this project.) We plan to follow-up with World Bank energy experts to put together a program to try to clarify this issue.

Comment

22. (SBU) The changes to the 9th Five-year-plan provide the firmest evidence that the MOEP has slowed its construction schedule to allow demand to catch up to supply, a process that will likely take some three years, depending upon overall economic conditions. The time required for demand to catch up to supply is also partly due to the fact that projects in the pipeline -- which are long lead-time projects -- that will continue to come on line over the next year or so are based on the previous, more rapid schedule. The overall slowdown will probably be felt the hardest by foreign firms, especially given the central government's preference for domestic content in its power plants.

23. (SBU) This surplus should be viewed in context, however, keeping in mind the fact that new construction, albeit slower, will nonetheless continue and probably pick back up in a few years time. Meanwhile, the surpluses are uneven and shortages must still be addressed in certain locations. In addition, construction in remote areas not served by the grids will continue to be a priority.

24. (SBU) While the World Bank's important role in China's development is indisputable, the consensus of many U.S. businessmen is that the strong evidence of willing financiers to China's power projects -- with an eye to the long-term demand -- suggests the World Bank's funds may be better spent on plants in remote areas, or in different sectors altogether. Not only would foreign financiers benefit from such a move, but Chinese Banks would also have greater opportunity to finance projects in this sector.

25. (U) Guangzhou minimize considered. Sasser

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