Annex 1

China National Energy Strategy and Policy 2020

Subtitle 7: Global Climate Change: Challenges, Opportunities, and Strategy Faced by China

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Abbreviation

BAU: Business as Usual

CCCPC: Central Committee of the Communist Party of China

CDM: Clean Development Mechanism

CERs: Certified Emission Reductions

DOE: Department of Energy

EIA: Energy Information Administration

ERI: Energy Research Institute

GDP: Gross Domestic Product

IEA: International Energy Agency

Mtce: Million tons of coal equivalent

NDRC: National Development and Reform Commission

NPC: National People's Congress

SDPC: State Development Planning Commission

UNFCCC: United Nations Framework Convention on Climate Change

Climate change is a typical global scale environmental issue. As early as 1970s, scientists have already pointed out that climate warming is a global environmental problem. Since 1980s, international scientific community and most countries in the world have been concerned about global warming and its impact on national economic and social development. Global climate change issue has a long time span with implications in different areas, such as, climate, environment, economy, society, politics, technology, and institution. Therefore, China's national climate change strategy should formulate from the starting point of the need of the long-term national social and economic development in an integrated framework of international politics, economy and foreign policy, in order to promote the national sustainable development. During the course of building an Overall Well-off Society and socialist country with Chinese characteristics, how to respond to the global climate change effectively in the context of sustainable development is a significant task for China.

1 Global Climate Change: China's Situation and Concerns

1.1 Basic situation in China concerning climate change

Over the past two decades, China has made rapid economic development and significant social achievements. However, as a country with the largest population in the world, a weak economic foundation and scarce natural resources, China is still in its initial stage of economic and social development. As a result, eradicating poverty, developing the economy and improving people's living standard are the first and overriding priorities for China at present and in the future.

1. Indigent population

China has the largest population in the world. By the end of 2003, the population reached 1292 million, accounting for about 21% of the world population. A huge population is one of the key reasons why it is so hard to eradicate poverty in some rural areas and why new poverty problems have appeared recently in some urban areas. By the end of 2003, there were still 26 million indigent people whose annual income was under poverty line of US$ 72 (￥625 RMB per year).

2. Development stage

As a country with low-income levels, the per capita GDP of China was only US$ 1090 in 2003, 19% of the world average and only 3% of that in high-income countries. In spite of the rapid economic development over the past two decades, China is still at a very low level developing stage with weak economic basis and unbalanced regional development. Even within the same region, there is great disparity in social and economic development between rural and urban areas.

3. Disparity between west and east of China

Remarkable disparity in social and economic development among different areas is one of the basic situations in China. Vast territory and complicated ecological, social and economic conditions attribute largely to this diversity. Since the end of 1970s, economy in coastal areas of eastern China grew rapidly for over 20 years. However, in western China, the growth rate fell far behind eastern China, causing the notable unbalanced development in China. In 2003, per capita income of eastern China was US$ 1960, while that of western China was US$ 743, nearly 62.1% lower than the former.

4. Disparity between rural and urban areas

China is one of the countries with a big disparity between rural and urban areas. Though much progress has been made in urbanization processes in China, the rural population is still accounted for 59.47% of the entire population in 2003. By the end of 2003, the per capita disposable income of urban people was US$ 1016.6, whereas that of rural people was US$ 314.6, only 30.95% of the former.

5. Consumption level

Just having adequate food and clothing, the Chinese residents are now on the way to a relatively well-off living standard. By the end of 2003, there were still 20 million rural residents had no access to electric power supply. In 2003, per capita commercial energy consumption and domestic electricity consumption was only 0.91 tons of oil equivalent (toe) and 156 kilowatt-hours (kWh), respectively, not only much lower than the level in developed countries, but also lower than the world average. As to vehicle ownership in China, it was only 15.87 vehicles per thousand people in 2000, much lower than that in developed countries.

6. Energy status

China’s energy structure is dominated by coal. By the end of 2000, per capita recoverable coal reserves were about 90 tons, while per capita recoverable oil and natural gas about 3 tons and 1080 m^3, respectively. Among the total proved reserves, coal shares 87.4%, oil 2.8%, natural gas 0.3%, and hydropower 9.5%. Production and consumption of primary energy is 1603 Mtce and 1678 Mtce respectively in 2003 in China, of which coal shares 67.2% in both cases. Also in 2000, net oil imports were up to 59.96 Mt.

7. Climate conditions

China covers multi-climate zones, experiencing cold temperate to equatorial monsoon zones. In the far reaches of northeastern China, the annual accumulated temperature is less than 1600℃ and the average temperature during the coldest month is lower than -30℃. In contrast, on islands in the South China Sea, annual accumulated temperature is over 9000℃ and the average annual temperature is

higher than 26℃. Even in the same area, annual temperature disparity is quite large. Taking Beijing as an example, the lowest temperature in 2000 was -15℃ (16^{th} January) and highest was 39.4℃(1^{st} July).

8. Ecological environment

China is a country with vulnerable ecological environment. Up to now, areas suffering from desertification have reached 2.62 million square kilometers, 27.3% of the country's surface area. Per capita freshwater resources in China were 2220 m^3 in 2000, about 1/4 of the world average. Furthermore, distribution of water resources is seriously unbalanced compared to the distribution of population, land, minerals and productive power. Per capita cultivated land in China is only 0.1 hectares, with a shortage of high-grade land and land reserve.

1.2 Challenges to China's development raised by global climate change

As a developing country, China takes her first and overriding priorities as social and economic development and poverty elimination. In a rather long term, China will still keep up her rapid economic development and improve her people's living standard considerably. Therefore, China will inevitably increase her energy demand and GHG emissions, which would further highlight China as a large GHG emitter and expose severe challenges to China's social and economic development.

Developed countries will keep on urging China to limit and control the GHG emission. After the Kyoto Protocol, there are some developed countries claim that the Kyoto Protocol has stipulated mitigation target for developed countries and try their best to urge the main developing countries such as China and India to limit the GHG emissions. Certain developed countries even declared that one of the preconditions for them to ratify Kyoto Protocol was developing countries' meaningful participation and its linkage with the Convention's financial mechanism. These claims run counter to the principle of "common but differentiated responsibilities" and the stipulation in the Convention--"the extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology, will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties." But still we can envision that it is difficult to lessen the pressure on developing countries to mitigate.

Climate change issue raises great challenge to China's current development and consumption mode. Natural resources provide the foundation for national economic development. Any countries' industrial structure and economic productivity are mainly determined by the endowment and structure of its natural resources. As it is well known, China has to pursue the long-term objectives of industrialization and urbanization with a gigantic population base and low development level. Therefore,

China will suffer a long-standing constraint of shortage of per capita natural resources for her economic development. As a resource-depleting, unsustainable consumption and production mode, the traditional consumption and production mode has already challenged China's social and economic development greatly. With respect to the choice of developing mode, every country in the world is entitled to select his own developing pattern based on his individual specific situation. But in the course of development, they have to follow some universal natural laws that few countries can make an exception. The developing history and trend of all countries in the world has showed remarkable evidences that per capita commercial energy consumption correlates closely with economic development stage. It can be predicated that if China carries on with current technology development and consumption mode, the per capita energy consumption will inevitably reach a much high level. Since there is no precedent of any country achieving high per capita GDP at relative low per capita energy consumption, China is confronted with the challenge to initiate a sustainable consumption and production mode.

Global climate change raises great challenge to China's energy mix predominated by coal. China's energy consumption and CO_2 emission will continue to increase as a result of rapid economic development and continuous population increase. It is predicated that China will probably emit more CO_2 than United States and become the top one GHG emitter by the year 2025. According to the current development trend, it can be predicated that China's per capita CO_2 emission may be higher than the-same-time world average by the end of 2030, due to its faster increasing rate, even though the current value is still much lower than the world average. China is one of the few countries that are mainly powered by coal with 1393 Mt of coal production in 2002, which accounts for nearly 30% of the world total coal consumption in the corresponding period. Nevertheless, CO_2 emission per unit heat output for coal is 36% and 61% higher than that of oil and natural gas, respectively. As China is not only constrained by the mix of energy resources in her energy mix adjustment but also by the lack of technology and investment in her energy efficiency improvement, the prospect of CO_2 emission control for China is difficult due to the coal-dominated mix in energy resources and consumption.

1.3 Opportunities for China's energy development offered by climate change

Global climate change raises great challenges for China. But on the other hand, it brings new development opportunities for China as well. At present, the policies and measures formulated by international community to mitigate CO_2 emissions mainly focus on energy efficiency improvement and renewable energy development, which not only meet the requirement for China to transform her current extensive economic development mode to an intensive one, but also contribute to China's energy efficiency improvement and energy mix optimization by its direct effect on promoting the diffusion of high energy efficiency technology and product around the world. It is suggested that China should take full advantage of this new developing opportunity

offered by global climate change, and act actively in related international cooperation field, which will not only contribute to a decent international image for China in global climate protection, but also can push the developed countries to fulfill their commitments under the Convention related to financial resources and technology transfer, and thereby create a more advantageous circumstance of international politics, economy and technology for China's social and economic development.

Climate change favors China to carry out sustainable development strategy. With respect to a variety of potential impacts that may be imposed on China by global climate change, China should take a wide range of climate change adaptation measures to obtain the benefits and avoid the harms, for example, to improve ecological and environmental conditions and to enhance carbon sinks in ecosystem. These measures will all contribute to China's social and economic sustainable development. In the meanwhile, China will formulate and implement a long-term climate change response strategy and action plan integrated with the sustainable development strategy in the context of UNFCCC (United Nations Framework Convention on Climate Change). It is believed that this kind of strategy can still further push China's progress in family planning, energy conservation, and optimizing the utilization of energy resources.

It favors China to obtain more advanced energy conservation technology and new energy technology, which will facilitate China's energy mix adjustment. If developed countries have to carry out substantive domestic GHG mitigation, they will probably transit their energy mix from oil preponderance to natural gas as well as developing various kinds of renewable energy resources, which will certainly bring great impacts on the world's energy mix and technology development and provide opportunities for China to transit the current coal-predominate, high-emission and pollution energy mix to a oil and gas dominate one. On the other hand, the pressure for developed countries to mitigate GHG emission will certainly boost technology innovation on energy conservation and new energy development and intensify the market competition of energy conservation and new energy technology. Therefore, there is no doubt that climate change will bring opportunity for the development of a new generation of energy technology. In the meantime, energy consumption in developed countries will be restrained, which to a certain extent will vacate more room of energy consumption for China's future development.

The adoption of GHG emissions mitigation policies and measures will contribute to reduction of air pollution in China. According to the findings of existing available research, at present, about 75% of China's total air pollutant emissions come from combustion of fossil fuels. This is a typical case of coal-smoke pollution. In recent years, in order to control air pollution, the government of China has been taking great efforts including legal, economic and technical measures, but none of these measures yield remarkable effect. Therefore, the options of coal substitution by carbon-free or low-carbon energy and improving energy efficiency are not only the requirement for China's CO_2 emission mitigation in the future, but also

the requirement for local environmental protection and air pollution reduction.

An active participation in international cooperation on addressing global climate change can elevate China's international status and image. China enjoys many advantages in international cooperation to implement UNFCCC. Therefore, China should participate actively in international climate change cooperation and take responsibilities compatible with its economic development level. This will produce a decent international image for China in global climate protection. On the other hand, China's participation in international cooperation can push the developed countries to examine their commitments of financial resources and technology transfer, which in turn favors the need of advanced technology and fund for China's sustainable development.

2 Primary Emission Demand of China's Well-off Society

2.1 Implications of social and economic development in Well-off Society

In order to assess the progress of building well-off society, National Bureau of Statistics has made a general and deep study on the index system of Well-off Society with the cooperation of the former State Development Planning Commission and Department of Agriculture. In the middle of 1990s, they succeeded to formulate "Fundamental Standards of China's Well-off Society for the whole nation" (hereafter referred to as simply "Standard for the whole nation"), "Fundamental Standards of China's Well-off Society for rural citizens" (hereafter referred to as "Standard for rural citizens") and "Fundamental Standards of China's Well-off Society for urban citizens" (hereafter referred to as "Standard for urban citizens"). These three sets of standard have won recognition from government departments and society, and ever since served as the main criteria to evaluate the progress of the people's well-off living. These sets of standards were mainly drawn up on the references in 4 aspects, as follows:

1. Resolutions, reports and documental spirits relating to China's modernization construction by the CCCPC (Central Committee of the Communist Party of China), or the NPC (National People's Congress), or State Council;

2. Quantitative and qualitative level of national people's living in all perspectives;

3. World average living standard;

4. Productivity level and national conditions at present.

As the common living standard to measure the level of national people's well-off living, "Standard for the whole nation" comprises 16 indexes in 5 categories (see table 2-1). The first category is economic development stage, which consists only of per

capita GDP; The second one is material well-being, which is constituted by disposable per capita income for urban citizens, per capita annual net income of rural households, per capita dwelling space for urban citizens, per capita housing space in steel concrete, brick and timber construction for rural citizens, per capita daily protein incept, road per million urban citizens, percentage of administrative villages access to open road, and Engelian coefficient; The third one is population quality, which comprises percentage of adults in literacy, average life expectancy, and infant mortality rate; The fourth one is cultural life, which is composed by percentage of expenditure on education and entertainment, and television diffusion rate; The last one is living environment, which consists of percentage of forest cover, and percentage of counties passing the rural primary health protection.

Table 2-1 Fundamental standards of Chinese people's well-off society

Index type	Denotation of index	Critical value			
		Unit	Year of 1980	Score in Well-off	Weight
Ⅰ. Economic development	1. Per capita GDP	RMB	778	2500	14
Ⅱ.Material well-being					48
Income	2. Annual per capita income				16
	⑴ Disposable per capita income for urban citizens	RMB	974	2400	6
	⑵ Per capita net income for rural households	RMB	315	1200	10
Housing conditions	3. Per capita living space				12
	⑴ Per capita dwelling space for urban citizens	m^2	5.5	12	5
	⑵ Per capita housing space in steel concrete or brick and timber construction for rural citizens	m^2	4.5	15	7
Nourishment	4. Per capita daily protein incept	g	50	75	6
Transportation	5. Transportation conditions in urban and rural areas				8
	⑴ Per capita paved road for urban citizens	m^2	2.8	8	3
	⑵ Percentage of administrative villages access to open road	%	50	85	5
Pattern of consumption	6. Engelian coefficient	%	60	50	6
Ⅲ.Population quality					14
Civilization	7. Percentage of adults in literacy	%	68	85	6
Health	8. Average life expectancy	Years	68	70	4

	9. Infant mortality rate	‰	34.7	31	4
Ⅳ.Cultural life					10
	10.Percentage of expenditure on education and entertainment	%	3	11	5
	11. Television diffusion rate	%	11.9	100	5
Ⅴ. Living environment					14
	12. Percentage of forest cover	%	12	15	7
	13. Percentage of counties passing the Rural Primary Health Protection	%		100	7
Total	16 sub-indexes as a whole				100

Source: "Road of China's Well-off Society", China's Statistic Press, 1999.

The 16th National Congress of the CPC, held in Beijing in November 2002, set forth the goal of building an Overall way well-off society in China. Henceforth, many domestic research institutes including Energy Research Institute pursued the analysis of energy demand for "Building an Overall Well-off Society", for the sake of which, the following key indexes were defined and quantified:

Economic growth rate: GDP be quadrupled to 36 trillion RMB at the end of 2020, equivalent to US$ 4 trillion at current exchange rate, which means the economy should keep on growing at better than 7% annual rate in the coming two decades.

Population growth and urbanization: population will be controlled within 1.5 billion by the end of 2020, while urbanization rate to reach 56% in 2020, growing at 1% annually.

Per capita GDP: by the end of 2020, per capita GDP expected to hit US$ 3000 (at current exchange rate), or US$ 10,000 (at PPP).

Average life expectancy: average life expectancy is 74 years in 2020, approximating the current level in high-income countries.

Housing conditions: housing conditions meeting the requirement of "1 house per household, 1 room per person, and well functioned and equipped by the end of 2020". It is predicted that per capita dwelling space for rural and urban citizens is 30 and 23~30 m^2/person, respectively.

Per capita domestic consumption of electricity: per capita domestic consumption of electricity reaches 712kWh, equivalent to the level of middle-income countries.

Engelian coefficient: Engelian coefficient decreases from present 40% to 30% in 2020, elaborated as 38% in rural area and 25% in urban area.

2.2 Analysis of basic energy demand for Well-off Society

Based on the above-mentioned quantitative indexes for "Building an Overall Well-off Society", the *Subject Group of Scenario Analysis of China's Energy Demand till 2020* from Energy Research Institute designed and analyzed 3 energy demand scenarios, which were named as BAU (Business as Usual) Scenario, Baseline Scenario, and Strengthened Policy Scenario. These 3 scenarios distinguish each other mainly in 2 driving variables, one is the strength to carry out the "Sustainable Development Policy" and the "degree of market opening "; the other is the adaptability to WTO accession and globalization (generally called Marketing Progress). Compared with the BAU Scenario, the Baseline Scenario is more successful in sustainable development, market economy and opening. And the Strengthened Policy Scenario is even more desirable in sustainable development policy, market construction, and adaptability to globalization than the Baseline Scenario. While the BAU Scenario does the worst whether in sustainable development, market construction, or market opening.

The scenario analysis indicates that in the BAU Scenario, China's primary energy demand in 2020 will amount to 3.25 billion tce (tons of coal equivalent) with most of the electricity depending on thermal power generation. While in the Strengthened Policy Scenario, the primary energy demand is 2.47 billion tce, of which more electricity demand is met by high efficiency non-fossil fuel power plants. The primary energy demand and mix of the three scenarios is listed in table 2-2 and Figure 1.

Table 2-2 China's primary energy demand and mix

Scenario	Type	Energy demand（Mtce）			Annual growth rate (%)	Mix (%)		
		2000	2010	2020	2000~2020	2000	2010	2020
BAU	Coal	907	1408	2027	4.10	69.9	65.2	61.5
	Oil	324	537	877	5.10	25.0	25.7	27.3
	Natural gas	36	111	218	9.39	2.8	5.2	6.7
	Primary electricity	29	69	127	7.59	2.3	3.9	4.5
	Total	1297	2126	3248	4.70	100	100	100
Baseline	Coal	907	1341	1776	3.42	69.9	65.4	61.4
	Oil	324	524	795	4.58	25.0	25.5	27.5
	Natural gas	36	107	193	8.73	2.8	5.2	6.7
	Primary electricity	29	79	129	7.68	2.3	3.9	4.5
	Total	1297	2051	2893	4.09	100	100	100
Policy	Coal	907	1205	1473	2.45	69.9	64.8	59.9
	Oil	324	460	638	3.44	25.0	24.7	25.8
	Natural gas	36	115	219	9.43	2.8	6.2	8.7
	Primary electricity	29	79	141	8.15	2.3	4.3	5.7
	Total	1297	1859	2471	3.27	100	100	100

Note: primary electricity is converted by the method of electro thermal equivalent

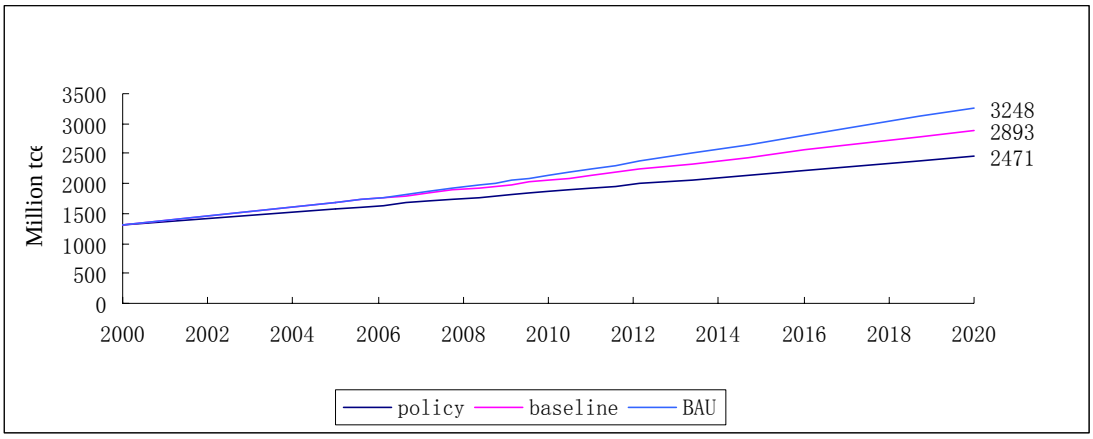

Figure 1 Comparison of total energy demand between three scenarios

Electrification rate is a key indicator to judge the living standard of one country. International experience and the facts in relatively developed regions of China have demonstrated that the demands for electricity and heat in residential/commercial sectors will increase remarkably as soon as per capita GDP reaches the level of middle-income countries or the Overall Well-off Society. In the Strengthened Policy Scenario, end-use electricity demand in 2020 will amount to 3.5 trillion kWh, which will put great pressure on resources and environment. In spite of the re-enforced rapid development of non-fossil fuel power generation, coal will still be the major fuel for electricity and as a result, accounting for about 60% of China's primary energy consumption. Figure 2, 3 and 4 shows the demand for coal, oil and natural gas in these 3 scenarios, respectively.

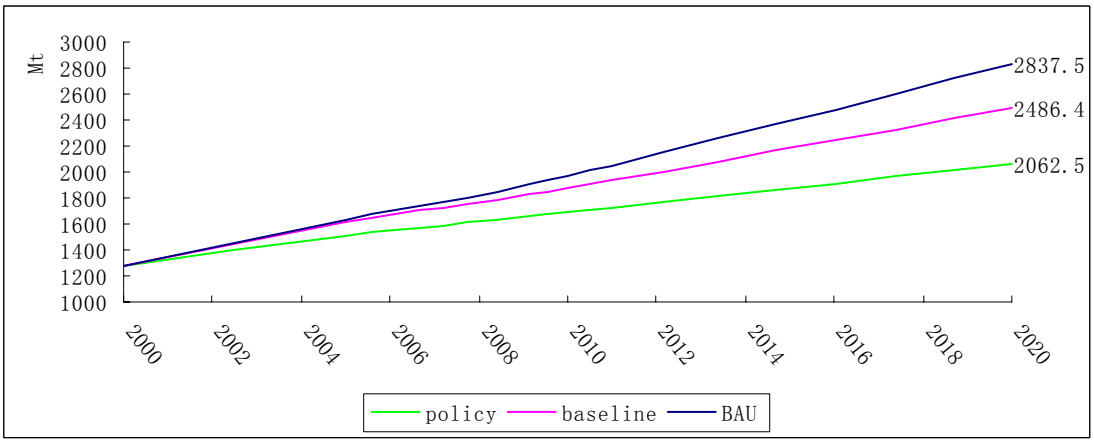

Figure 2 Coal demand of three scenarios

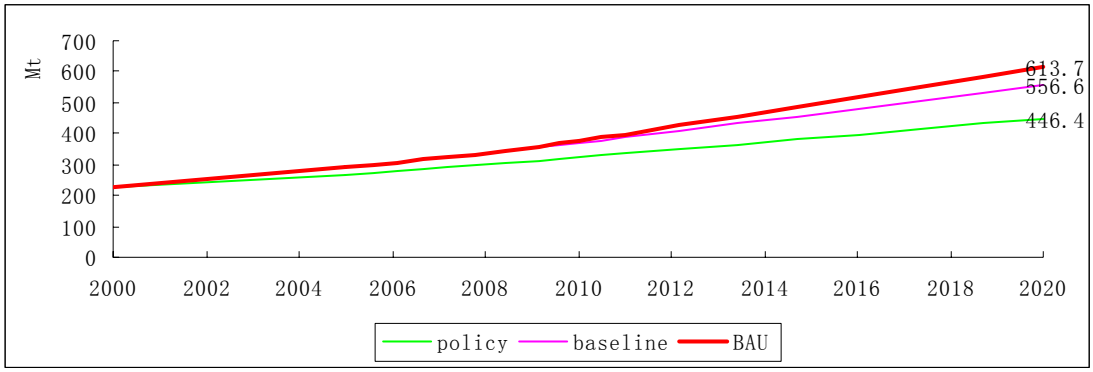

Figure 3 Oil demand of three scenarios

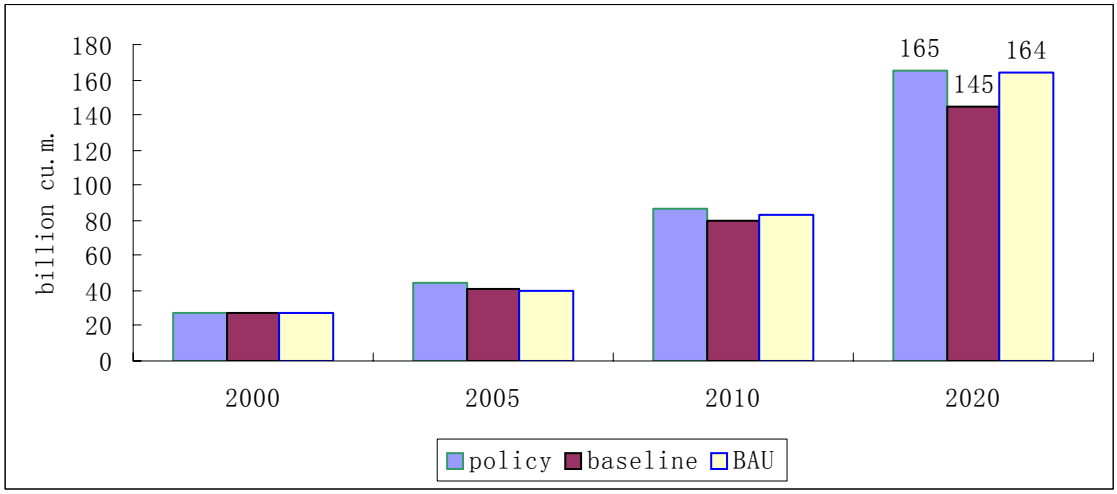

Figure 4 Natural gas demand of three scenarios

As to the primary energy demand and energy mix by sectors, along with the rapid increase of energy consumption both in residential/commercial and transport sectors, the share of energy demand in industrial sector will drop continuously. For example, in the Strengthened Policy Scenario, the share of energy demand in industrial sector will decrease from 72.7% in 2000 to 56.7% in 2020. Meanwhile, the share of residential/commercial will increase to 26.7% at the fastest growth rate, 10.5% higher than that in 2000. As for the other 2 scenarios, the share of energy demand in industrial sector will also decrease to 60% below. The common trend shows that after the industrialization, the growth of productive energy demand will slow down, while the energy demand in service sectors such as housing and transportation will grow rapidly.

Table 2-3 China's primary energy demand by sectors, 2000-2020

Scenario	Sector	Energy consumption (Mtce)			Annual growth rate (%)
		2000	2010	2020	2000~2020

Policy	Industry and agriculture	943	1239	1401	2.00
	Transportation	145	246	410	5.34
	Commercial/residential	210	374	661	5.90
	Total	1297	1859	2471	3.27
Baseline	Industry and agriculture	943	1372	1662	2.88
	Transportation	145	274	494	6.33
	Commercial/residential	210	405	737	6.48
	Total	1297	2051	2893	4.09
BAU	Industry and agriculture	943	1421	1904	3.58
	Transportation	145	282	534	6.75
	Commercial/residential	210	423	810	6.99
	Total	1297	2126	3248	4.70

Note：The primary energy demand is converted from the energy end-use of the three major sectors

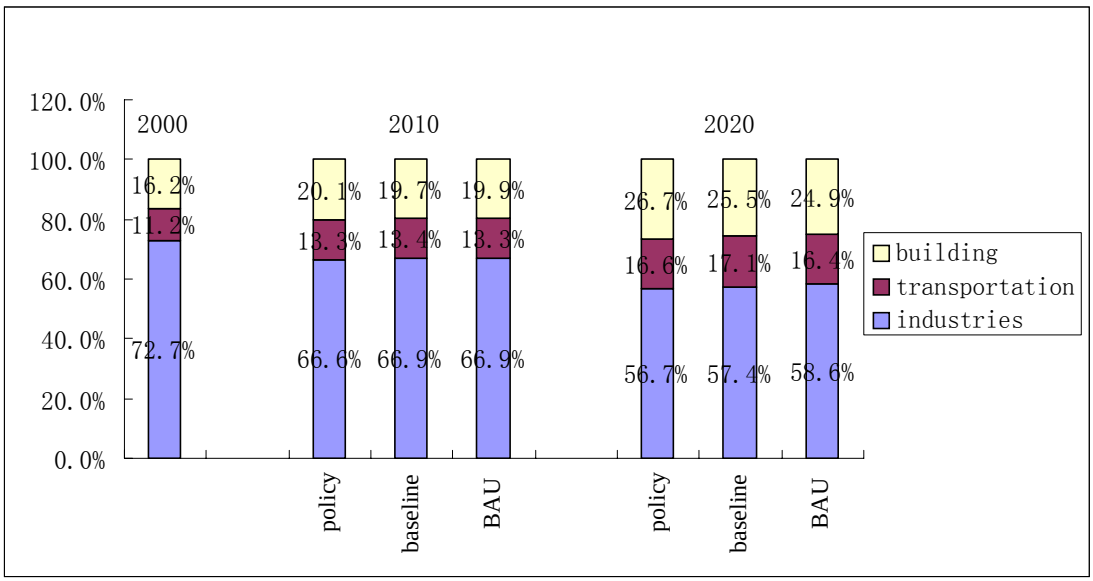

Figure 5 Comparison of primary energy mix between three major sectors

2.3 Analysis of primary emission requirement for Well-off Society

2.3.1 CO_2 emission status quo

(1) National total emission

Up to the present, the government of China has not yet formally published any official data on national GHG emissions inventory. Nevertheless, EIA (Energy Information Administration of Department of Energy, USA) published its estimation on CO_2 emissions from the fossil fuels combustion of most countries in the world

(including China in 1990-2001, see Table 2-4 and Figure 6). According to EIA estimation, during 1980 to 2001, China's CO_2 emission from combustion of fossil fuels increased from 394 to 832 million tons of carbon, growing at average 3.62% annually in 21 years. In 2001, China contributed to 12.7% of world total carbon emissions, ranking second next to the United States.

Table 2-4 China's CO2 emission from the fossil fuel combustion , 1990-2001

(Mt-C)

	1990	1994	1995	1996	1997	1998	1999	2000	2001
IEA	616.89	768.01	787.72	803.15	824.28	805.20	790.95	780.37	831.74

Source: http://www.eia.doe.gov/emeu/international/total.html#Carbon, EIA, International Energy Outlook 2003.

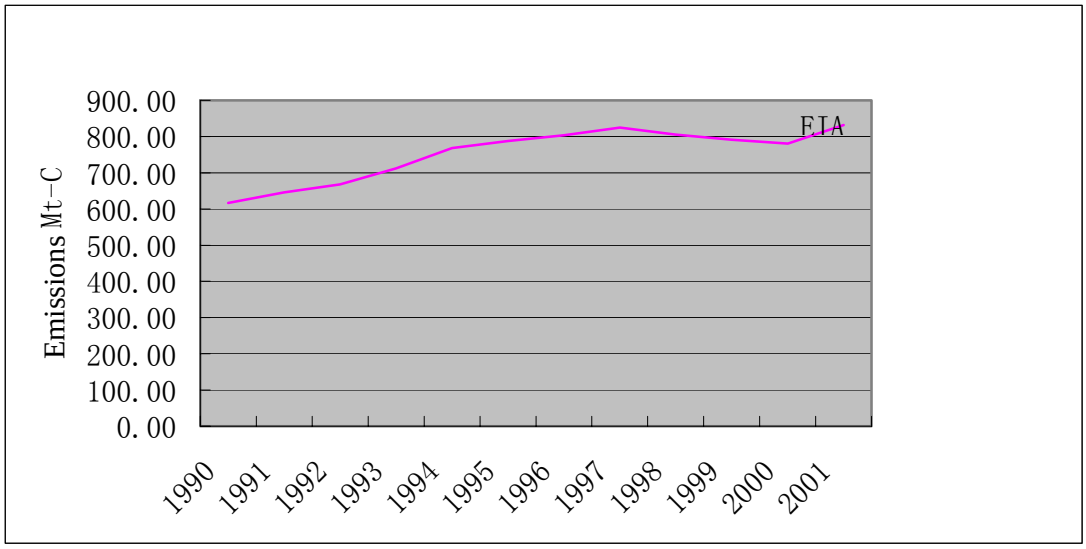

Figure 6 China's CO_2 emission trend in 1990-2001

(2) Per capita emission

Despite large national emissions, the per capita emission in China is still very small. In 2001, per capita emission in China was only 0.65t-C, corresponding to 61% of the world average (1.07t-C). Table 2-5 and Figure 7 shows the per capita CO_2 emission and trend during 1990-2001.

Table 2-5 Per capita carbon emissions in China, 1990-2001

(t-C)

	1990	1994	1995	1996	1997	1998	1999	2000	2001
Per capita emission	0.53	0.64	0.65	0.65	0.66	0.64	0.63	0.61	0.65

Source：http://www.eia.doe.gov/emeu/international/total.html#Carbon.

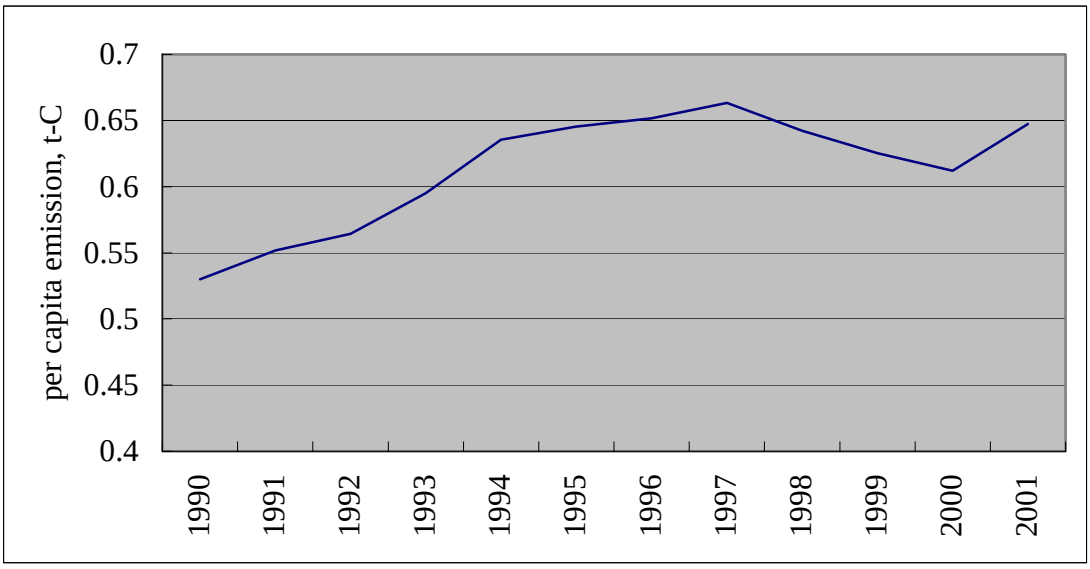

Figure 7 China's per capita CO_2 emission and trend during 1990-2001

(3) CO_2 emission intensity per GDP

CO_2 emission intensity per GDP (CO_2/GDP) is a key indicator to represent the energy mix, economic efficiency and energy efficiency of one country, which in recent years has caught much attention from scientific community and national governments. Table 2-6 lists the findings of China's CO_2 emission intensity by several institutes, and Table 2-7 and Figure 8 are China's CO_2 emission intensity and trend during 1990-2001 published by EIA.

Table 2-6 China's carbon emission intensity per GDP according to the publication of several research institutes

Carbon emission intensity	Sources and references	Comments
0.75 t-C/kUS$（2001）	EIA	Only taking into consideration the CO_2 emission from fossil fuel combustion; In 1995 constant US$ price and exchange rate.
1685 t-C/M US$ (1990); 865 t-C/M US$ (1999)	*Handbook of Energy & Economic Statistics in Japan*, IEE of Japan, 2002.	In 1995 constant US$ price
5.69kg-CO_2/ US$ (1990); 3.09kg-CO_2/ US$ (1999); 2.88kg-CO_2/ US$ (2000)	IEA, *CO_2 Emissions from Fuel Combustion 1971-2000*.	In 1995 constant US$ price and exchange rate

Table 2-7 China's carbon emission intensity according to the publication of EIA

(t-C/kUS$, 1995 constant price)

1990	1994	1995	1996	1997	1998	1999	2000	2001
1.55	1.21	1.12	1.05	0.99	0.89	0.82	0.75	0.75

Source：http://www.eia.doe.gov/emeu/international/total.html#Carbon

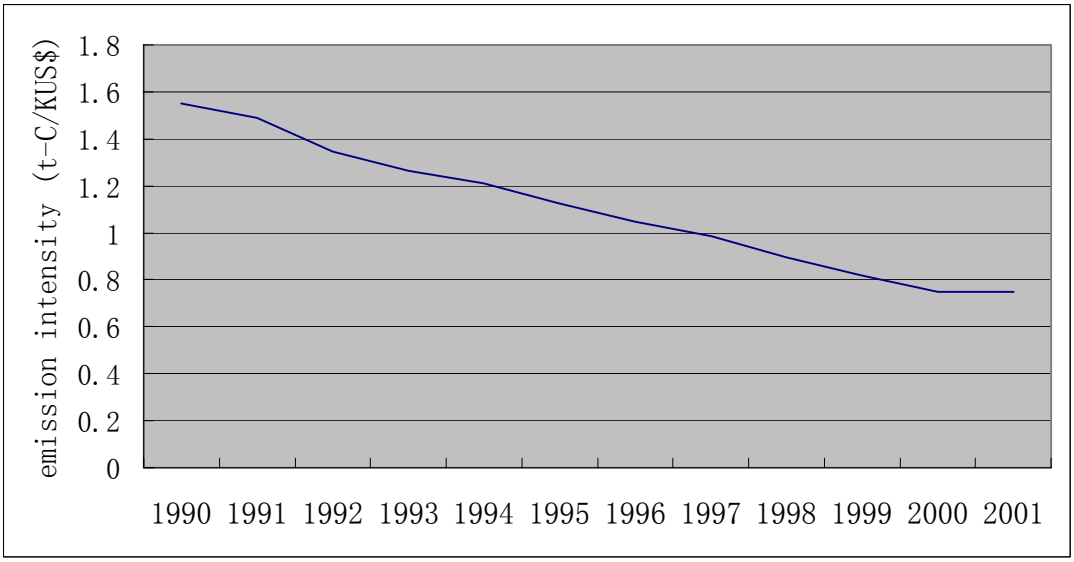

Figure 8 China's carbon emission intensity per GDP in 1990-2001

2.3.2 China's CO_2 emission scenarios in 2020

According to the findings of Scenario Analysis of China's Energy Demand till 2020, China's CO_2 emission in 2020 would amount to 1.940, 1.716 and 1.437 billion tons of carbon in the above-mentioned scenarios respectively. (As showed in Figure 9).

The main reason of the difference among the 3 scenarios is energy demand and mix. In the 3 scenarios, the fossil fuel demand is 3.12, 2.76 and 2.33 billion tons respectively, of which their respective coal demand is 2.03, 1.78, and 1.47 billion tce, accounting for 65.1%, 64.5% and 63.1% of the fossil fuel demand, respectively.

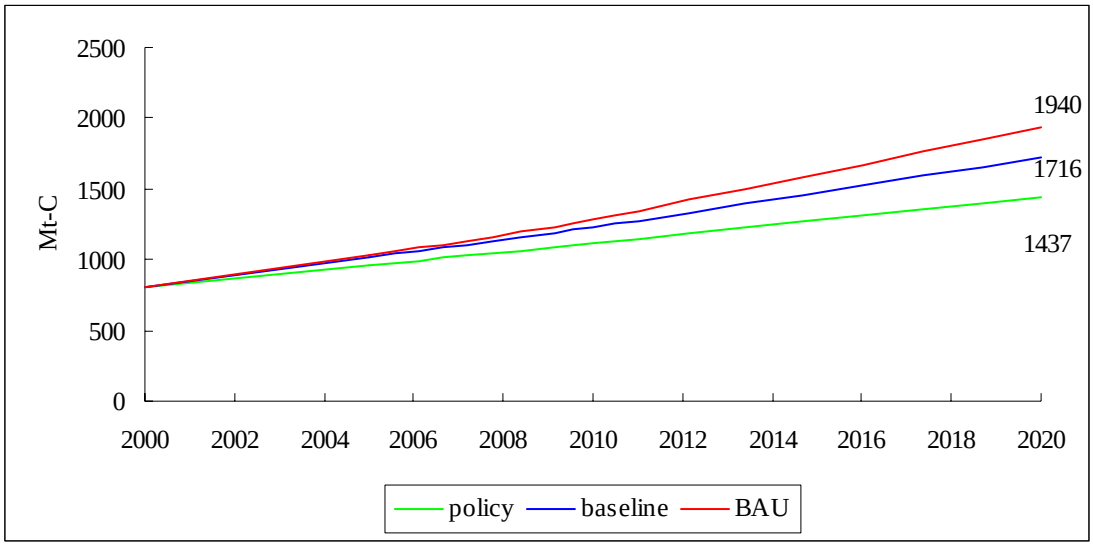

Figure 9 Comparison of carbon emission among three scenarios

With respect to per capita CO_2 emission (see Figure 10), in the BAU scenario, per capita CO_2 emission of China in 2020 will reach 1.31 t-C, more than the double of that in 2000 and higher than the current world average, but still much lower than per capita emission of 3.02 t-C in OECD countries in 2000. While in the Strengthened Policy Scenario, thanks to the measures such as energy mix optimization and energy efficiency improvement, per capita CO_2 emission will grow at a more moderate rate and only be 1.0 t-C in 2020, 57% higher than that in 2000, 94% of current world average and only 33% of current level in OECD countries.

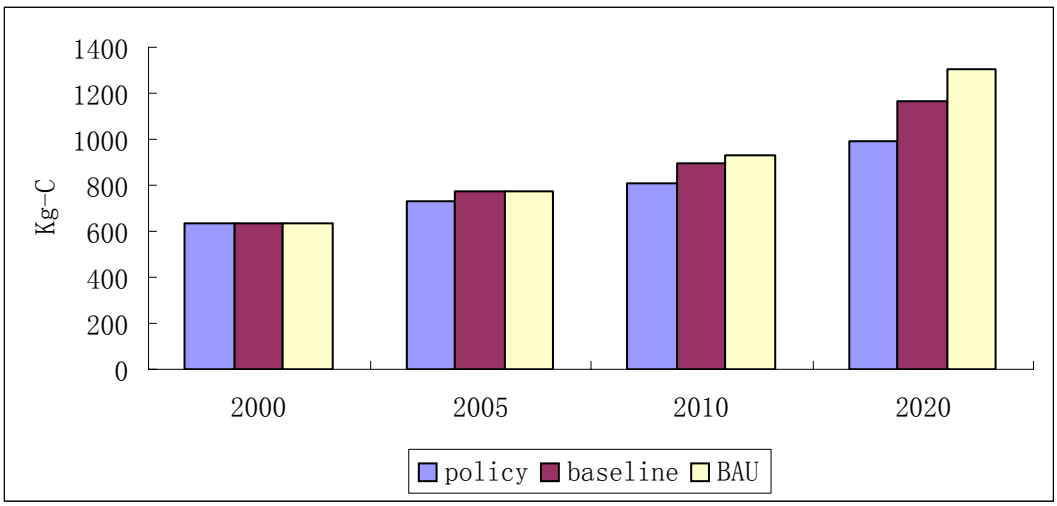

Figure 10 Comparison of per capita CO_2 emission among three scenarios

As for CO_2 emission by sectors (please refer to table 2-8), industrial sector will

still be the major CO_2 emission source. In the 3 scenarios, the CO_2 emission from industrial sector will be 820, 990 and 1150 million tons of carbon, respectively, accounting for 57-59% of their respective total CO_2 emission.

Due to the rapid growth of energy demand in transportation and buildings, the share of CO_2 emission from these 2 sectors will increase continuously. In BAU Scenario, CO_2 emission from residential/commercial sector will increase from 130 million tons of carbon in 2000 to 480 million tons of carbon in 2020, growing at 6.8% annual rate, meanwhile the share of which in national total emission increased from 16.1% to 24.7%. In the Strengthened Policy Scenario, thanks to the various measures to improve energy efficiency, the growth rate will slow down to 5.5%, and the CO_2 emission from residential/commercial sector will reach 377 million tons of carbon in 2020, however, accounting for as high as 26.3% of the national total emission.

Table 2-8 Comparison of CO_2 emissions by sectors during 2000-2020

Scenario	Sector	CO_2 emission (Mt-C)			Annual growth rate (%)	Mix by sector (%)		
		2000	2010	2020	2000~2020	2000	2010	2020
Policy	Industry and agriculture	586	745	821	1.7	73.2	67.1	57.1
	Transportation	85	144	239	5.3	10.7	13.0	16.6
	Commercial/residential	129	221	377	5.5	16.1	19.9	26.3
	Total	801	1111	1437	3.0	100.0	100.0	100.0
Baseline	Industry and agriculture	586	831	994	2.7	73.2	67.4	57.9
	Transportation	85	160	289	6.3	10.7	13.0	16.8
	Commercial/residential	129	242	433	6.2	16.1	19.6	25.2
	Total	801	1234	1716	3.9	100.0	100.0	100.0
BAU	Industry and agriculture	586	868	1147	3.4	73.2	67.4	59.1
	Transportation	85	165	313	6.7	10.7	12.8	16.1
	Commercial/residential	129	255	480	6.8	16.1	19.8	24.7
	Total	801	1288	1940	4.5	100.0	100.0	100.0

2.3.3 International comparison in main emission indexes

(1) National total emission

China contributes to 12% of the global total carbon emissions, ranking the second next to the United States. Table 2-9 compares the CO_2 emission from fossil fuel combustion of the major main countries in the world in 1990, 2001 and 2020.

There are many reasons why China is a large GHG emitter in the world, such as its level of development, size of the economy, economic structure, energy mix, climatic condition and large population. In light of the objective of “Building an Overall Well-off Society at the end of 2020”, China’s economy will keep on growing at a high speed and consequently the CO_2 emission will increase inevitably.

According to the findings of Scenario Analysis of China's Energy Demand till 2020 and the estimation of EIA, China's CO_2 emission in 2020 will reach 1.7-1.8 billion tons of carbon, accounting for 18-19% of world total at the same time, still ranking second next to the United States.

Table 2-9 Historical, current and projected CO_2 emissions of world major countries

(Mt-C)

Country	1990	2001	2020
US	1352	1559	2082
Russia	1036	654	939
Japan	269	316	365
Germany	271	223	241
UK	164	153	176
Canada	129	155	196
Italy	113	121	140
France	102	108	122
China	617	832	1574 (Baseline) 1804 (High GDP Growth scenario)
India	153	250	435
Brazil	68	95	180
Mexico	84	96	207
Global total	**5872**	**6522**	**9372**

Source: EIA, International Energy Outlook 2003.

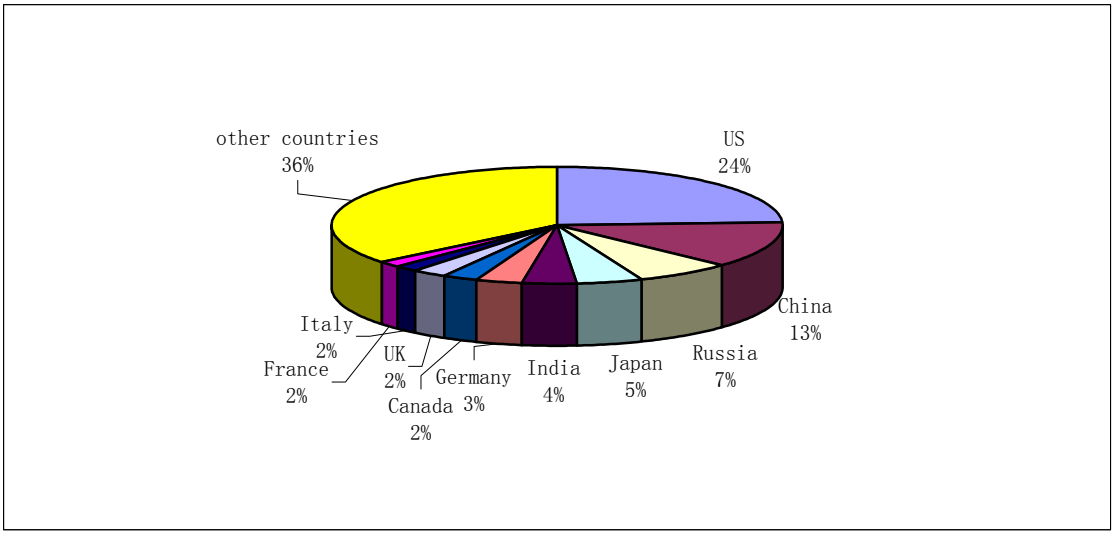

Figure 11 Global distribution of CO_2 emission from fossil fuels combustion in 2001

(2) Per capita CO_2 emission

As a country with the most population in the world, although China ranks the second in national total emission, per capita CO_2 emission was only 0.65 t-C in 2001, only 61% of world average (please see Figure 12). Per capita CO_2 emission is the direct reflection of per capita energy consumption, which in turn has straight-line dependence on the quality of life. Therefore, per capita emission is decided by many factors, including economic size and structure in industry, economic development level, share of non-fossil fuels in total primary energy consumption, energy efficiency, climatic conditions, city layout and urban structure, transport mode, life style, land area and population density, etc.

The developed countries have transited from the stage of sufficient food and clothing to the stage of richness and amenity for a long time. Other than for the fundamental life requirements, most of their material production, energy consumption and GHG emission are directed to the much higher level demand for spirit enjoyment such as entertainment, tourism, and cultural life, which illuminates the great gap in life quality between developing and developed countries. For example, per capita CO_2 emission in OECD countries in 2001 reached 3.36 t-C, as 5.16 times as that of China. Difference in per capita CO_2 emission is another evidence of the gap in life quality between developed and developing countries.

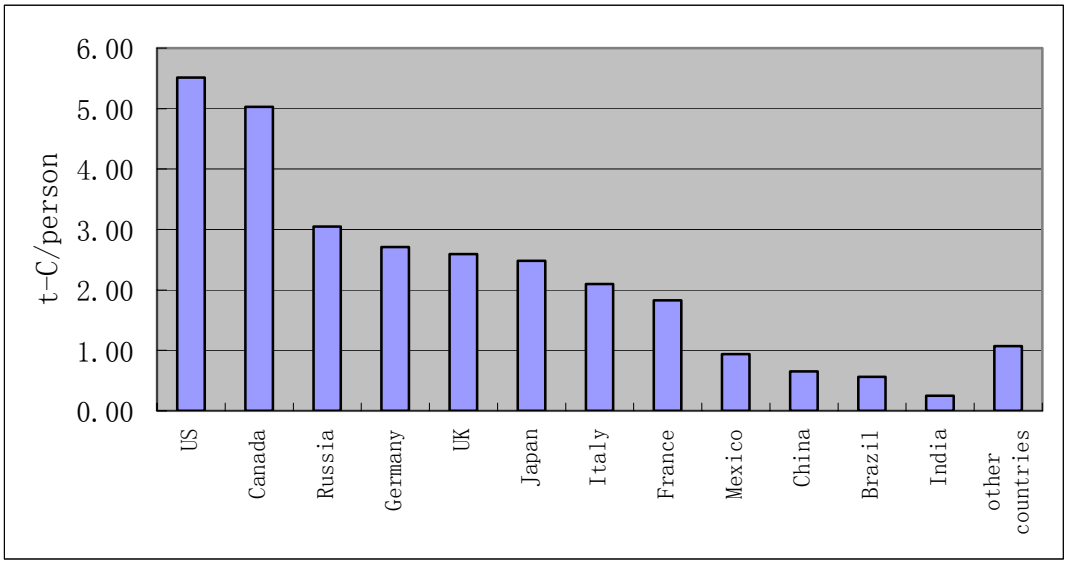

Figure 12 Comparison of per capita CO_2 emission among world major countries in 2001

According to the findings of Scenario Analysis of China's Energy Demand till 2020, in the BAU scenario, per capita CO_2 emission of China in 2020 will reach 1.31 t-C; in the Strengthened Policy Scenario, per capita CO_2 emission will grow only be 1.0 t-C in 2020.

Economic development and the improvement of living standard will result in a rising tendency of per capita CO_2 emission in China. According to the findings of Scenario Analysis of China's Energy Demand till 2020 and the projection of high

GDP growth scenario by EIA, per capita CO_2 emission in China in 2020 will reach 1-1.23 t-C, corresponding to 86% of 1.43 t-C of world average then. Meanwhile, per capita CO_2 emission in developed countries will be as high as 4.37 t-C.

(3) CO_2 emission intensity per GDP

CO_2 emission intensity per GDP depends on two elements: energy consumption intensity per GDP and carbon intensity per energy supply. Practical situations in countries demonstrate that the trend of CO_2 emission intensity is consistent with that of energy consumption intensity. In the past two decades, China's energy consumption intensity has been dropping down continuously owing to the raising of energy efficiency, adjustment of industrial structure, and improvement of energy mix via national development of hydroelectricity, nuclear electricity and renewable energy. With these efforts, China's CO_2 emission intensity per GDP decreased by 52% during the period of 1990-2001.

According to the estimation of EIA, at the end of 2020, China's CO_2 emission intensity per GDP will drop down to 0.40 t-C/ kUS$ at 2.7% annual rate, the highest rate among the countries in the world (see table 2-10).

Table 2-10 Development trend of China's carbon emission intensity per GDP

（t-C/kUS$，1997 constant price）

	2001	2005	2010	2020	2025	2000-2025
Emission intensity	0.693	0.555	0.506	0.400	0.363	-2.7

Source: EIA, International Energy Outlook 2003.

As showed in Figure 13, China's CO_2 emission intensity per GDP is much higher than that of other countries. This can be explained by many factors, such as the difference in technological progress, economic growth pattern, industrial structure, modernization and urbanization process, etc. Furthermore, CO_2 emission intensity per GDP is very vulnerable to economic fluctuation (growth rate, market exchange rate, and inflation, etc.) and fails in the requirement of strict scientific objectivity for its intrinsic large uncertainty. Therefore, CO_2 emission intensity per GDP is not a good indicator for comparison between countries.

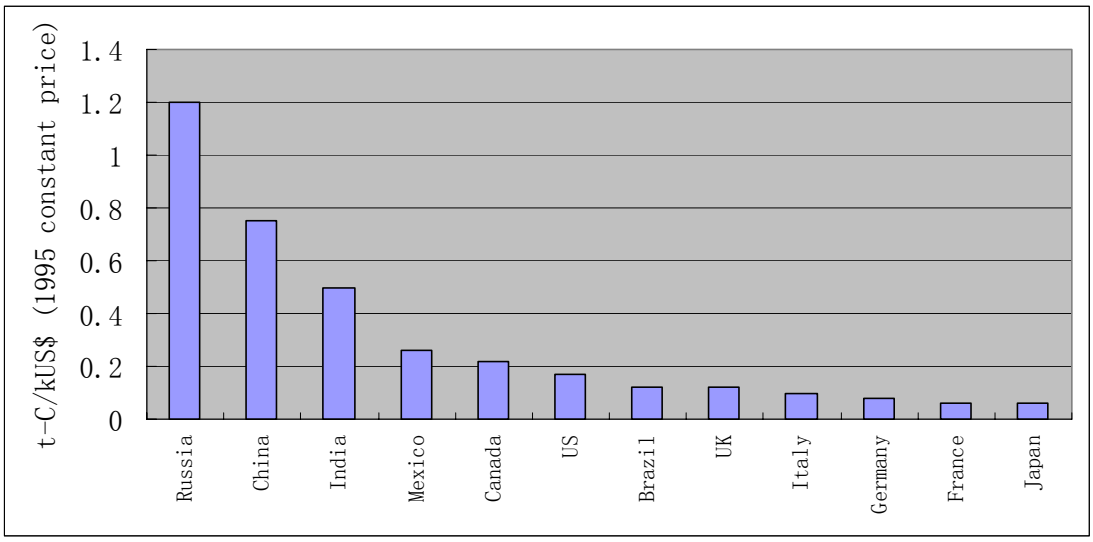

Figure 13 Comparison of carbon emission intensity per GDP among world major countries in 2001

Table 2-11 CO_2 emission intensity per GDP of world major countries

(t-C/kUS$, in 1995 constant price)

Country	1990	1994	1995	1996	1997	1998	1999	2000	2001
US	0.21	0.20	0.20	0.19	0.19	0.18	0.18	0.18	0.17
Russia	NA	1.36	1.32	1.37	1.20	1.26	1.29	1.23	1.20
Japan	0.05	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.06
Germany	NA	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.08
UK	0.16	0.14	0.13	0.14	0.13	0.12	0.12	0.12	0.12
Italy	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10
France	0.07	0.06	0.06	0.07	0.06	0.07	0.06	0.06	0.06
Canada	0.24	0.23	0.23	0.23	0.23	0.22	0.23	0.23	0.22
China	1.55	1.21	1.12	1.05	0.99	0.89	0.82	0.75	0.75
India	0.55	0.56	0.62	0.58	0.56	0.54	0.51	0.52	0.50
Brazil	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Mexico	0.32	0.29	0.30	0.31	0.29	0.31	0.30	0.27	0.26

Source：http://www.eia.doe.gov/emeu/international/total.html#Carbon

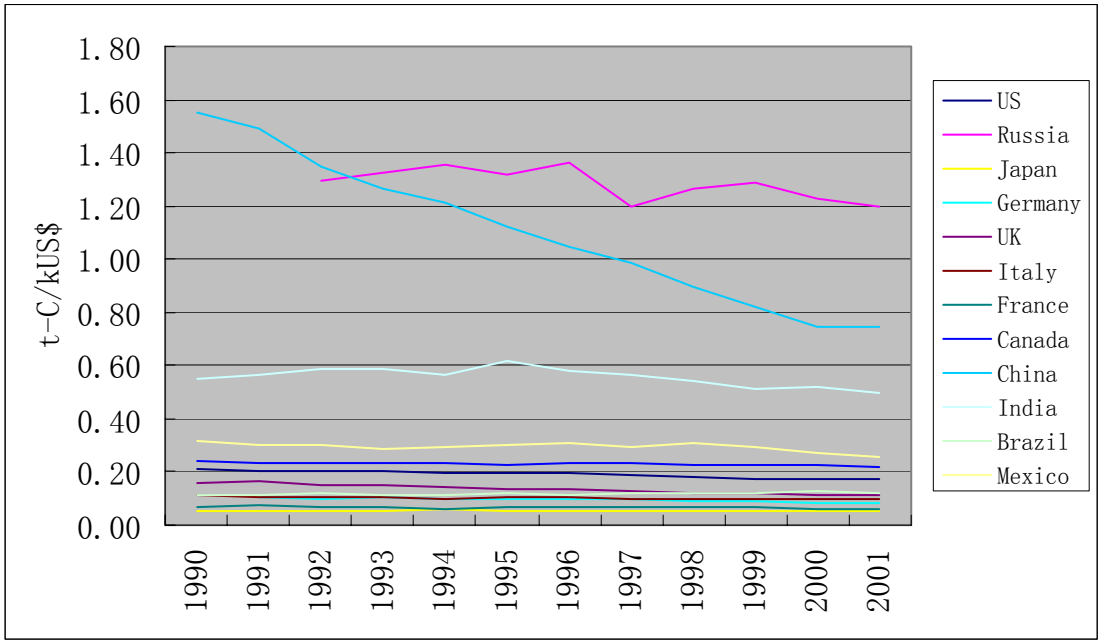

Figure 14 Developing trend of carbon emission intensity per GDP of world major countries during 1990-2001

(4) CO_2 emission intensity per unit of energy consumption

CO_2 emission per unit of energy consumption (CO_2/TPES) is also a relative index to reflect the development trend of one country's CO_2 emission. Table 2-12 plus Figure 15 and Figure 16 show the developing trend and CO_2 emission intensity per unit of energy consumption of world major countries published by International Energy Agency (IEA).

Table 2-12 CO_2 emission intensity per unit of energy consumption of world major countries

(t-CO_2/TJ)

Country	1990	1994	1995	1996	1997	1998	1999	2000
US	59.81	59.18	58.44	59.03	59.57	59.48	58.31	58.84
Russia		58.94	60.39	60.51	58.22	58.89	58.36	58.58
Japan	55.45	54.00	52.77	52.66	51.70	51.47	52.25	52.57
Germany	64.77	61.91	61.14	61.76	60.50	59.71	58.17	58.58
UK	62.96	55.84	56.73	55.94	55.12	55.21	54.33	54.56
Italy	63.02	61.51	61.71	61.40	61.16	61.04	59.79	59.27
France	37.27	35.70	35.30	34.81	35.11	36.13	35.26	34.67
Canada	49.14	47.02	47.53	48.01	49.14	49.97	49.68	50.13
China	61.92	67.05	66.59	67.38	65.51	66.58	63.53	62.65
India	38.80	42.76	43.76	44.55	44.77	44.79	45.11	44.60
Brazil	34.82	35.86	37.16	38.14	38.88	38.68	39.07	39.55

Mexico	56.24	57.08	56.25	55.66	56.00	56.86	54.83	55.94

Source: IEA, CO_2 Emissions from Fuel Combustion 1971-2000.

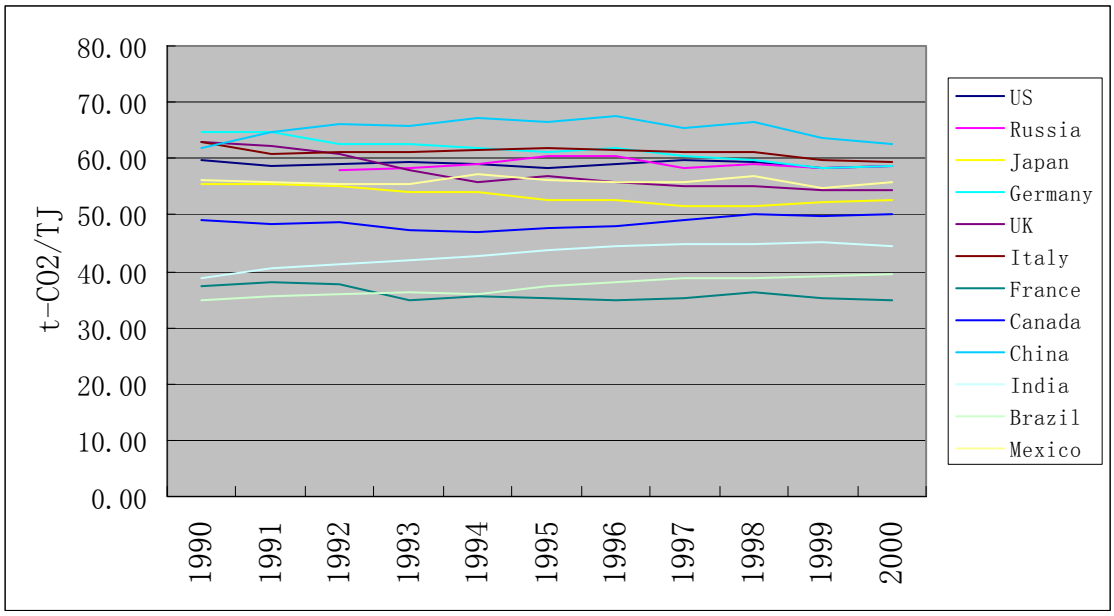

Figure 15 Comparison of CO_2 emission intensity per unit of energy consumption among world major countries

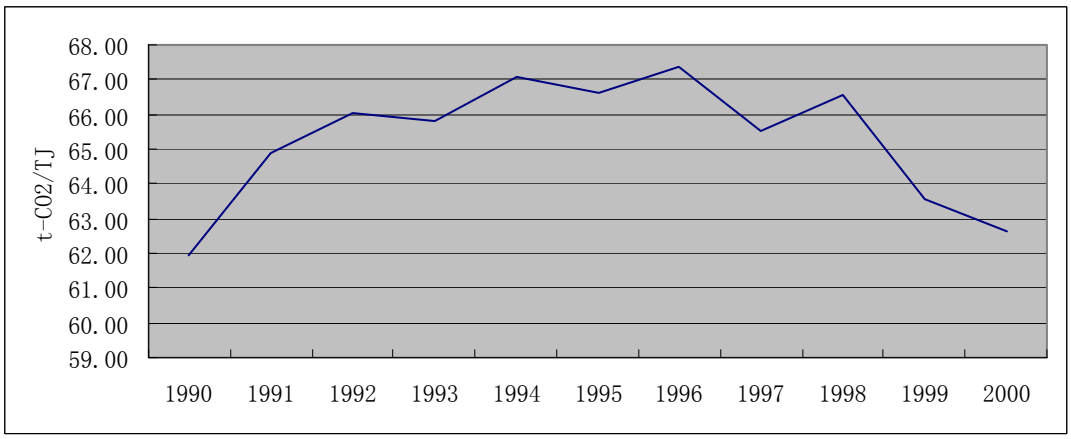

Figure 16 Developing trend of China's CO_2 emission intensity per unit of energy consumption

3 Addressing Climate Change within the Framework of Sustainable Development

3.1 Challenges in China's sustainable development strategy

As a developing country, China has achieved high economic growth rate with relatively low growth rate of energy consumption and CO_2 emissions, compared with that of developed countries in the same development stage. It is a great achievement at the existing development stage and technology level. However, economic foundation in China is still very weak, and the quality of people's living is still low. Therefore, eradicating poverty, developing economy and improving people's living standard are the first and overriding priorities for China in current period and in the long term to come. Nevertheless, in the course of achieving sustainable development and mitigation of global climate change, China on the whole faces the following significant challenges:

Challenge I: Huge and increasing population. High growth rate plus large population base number is one of the root reasons why it is so hard to eradicate poverty in some rural areas and why new poverty problems returned recently in some urban areas. In the traditional economic pattern, large population and high growth rate inevitably demand for more and more consumption of natural resources and consequently more and more CO_2 emission. Therefore, China is confronted with the great challenge of sustainable population development.

Challenge II: Unsustainable development pattern. The history and development trend of world countries have well demonstrated that there is a strong positive correlation between per capita commercial energy consumption and economic development stage. In other words, under the current technological level and consumption patterns, there is no precedent for a country to achieve high per capita GDP at relative low per capita energy consumption. As a developing country, China is still in the developing stage to develop economy at the expense of excessive consumption of natural resources and high pollutant emission. Instead of following the old energy-intensive developing pattern as developed countries did, China has no choice but to create a brand-new energy and technological system leading to sustainable development, which is a real challenge for China.

Challenge III: Shortage of fund. Capital shortage is always one of the real challenges for developing countries in the course of economic development and environmental protection. Since the beginning of reform and opening to outside world two decades ago, foreign investment in China has expanded greatly and continuously. However, shortage of fund is still the problem that deters the progress of eradicating poverty, closing the gap between rural and urban areas, and mitigating environmental pollution.

Challenge IV: lagging in technology. One of the main reasons for China's relatively low energy efficiency is out-of-date technology in the sector of energy production and utilization. At present time, China's energy-related technology lags behind developed countries by 10-15 years. Deficiency of advanced technology has resulted in China's energy exploitation efficiency 30% lower than that of developed countries, 5% lower for transformation and transition efficiency, 10% lower for end-use efficiency, and 10-20% lower for aggregate efficiency in total system. For example, China's specific energy consumption per unit of energy-intensive product is 40% higher than that of developed countries. Therefore, introduction of advanced technology would make great contribution to raising energy efficiency, resource allocation optimization, traditional industry renovation, environment improvement, and CO_2 emission mitigation.

Challenge V: Outstanding inconsistency in energy supply and consumption mix. The most pressing problem is the increasing gap between oil demand and supply, which resulting in deeper and deeper oil external dependence and great challenge to China's energy supply security. On the other hand, excessive proportion of raw coal was utilized directly in end-use sectors, while the share of cleaner energy such as natural gas, hydropower, wind power and solar energy is still extremely low. There are many great difficulties for China to utilize renewable energy and cleaner energy on a large scale. In the meantime, the potential for further energy conservation has diminished as the low-cost energy-saving opportunities have been fully utilized.

Challenge VI: vulnerability to climate damage. China has been suffering heavy loss from climate change and natural disasters. These disasters are going from bad to worse and triggering off more new problems, which inevitably cause great damage on infrastructure, ecological environment and economic development and consequently give far-reaching impact on China's sustainable development. Since ecological environment is the fundamental condition for human being's survival and development and foundation for economic and social development, human kinds have to adapt themselves to the ecological environment and climate change. However, at current economic developing stage, it is very hard for China to cover the cost of climate change adaptation. Therefore, it is a great ordeal for China to adapt the coming climate change and defend against the latent climate damage.

3.2 China's economic structure adjustment and impact on GHG emissions in the future

Based on the projection of economic structure change in the future, the corresponding reduction of CO_2 emission in 2020 by the economic structure optimization in comparison with that of 2000 was calculated (please see Table 3-1). It shows that 100.99 million tons of carbon emission will be reduced in 2020 due to the expected economic structure change, of which 33.69 and 81.71 million tons of CO_2 goes to the decrease of share in primary and secondary industry, respectively.

Meanwhile, The increased proportion in tertiary industry will gain 14.41 million tons of carbon emission.

Table 3-1 China's relative CO_2 reduction in 2020 owing to industrial structure adjustment

	Primary industry	Secondary industry	Tertiary industry	Total
Structure of production in 2000 (%)	15.9	50.9	33.2	100
Structure of production in 2020 (%)	9.0	48.0	43.0	100
GDP in 2020 (billion RMB)	326.3	1740.5	1559.2	3626.0
Industrial value change due to structure change (billion RMB)	-250.2	-105.2	+355.3	
Specific coal consumption per GDP in 2020 (tce/10^4RMB)	0.72	9.15	0.19	
Specific oil consumption per GDP in 2020 (tce/10^4RMB)	1.53	2.17	1.22	
Natural gas consumption per GDP in 2020 (tce/10^4RMB)	0.00	0.21	0.25	
CO_2 mitigated from coal combustion (Mt-C)	-12.73	-68.02	+4.77	-75.98
CO_2 mitigated from oil combustion	-20.96	-12.50	+4.87	-28.59
CO_2 mitigated from natural gas combustion (Mt-C)	0.00	-1.19	+4.77	+3.58
Total (Mt-C)	-33.69	-81.71	+14.41	-100.99

Source: Estimated by this sub-subject based on the findings of "Scenario Analysis of China's Energy Demand 2000-2020"

3.3 China's energy mix adjustment and impact on GHG emissions in the future

As is well known, there is relative large difference in CO_2 emission for the same economic output service but with different energy mix, which is caused by the great difference in carbon content and combustion efficiency for different energy types. Therefore, Using more low-carbon-content, high-combustion-efficiency energy, i.e. energy mix optimization, can effectively reduce GHG emission. Table 3-2 lists the corresponding reduction of energy consumption and CO_2 emission in 2020 contributed to the energy mix optimization in comparison with that of 2000. It shows that compared with the energy mix in 2000, coal share in 2020 drops 4.71%, corresponding to reduction of 130.05 Mtce coal consumption and 91.90 Million tons of carbon emission; oil share drops 1.24%, corresponding to reduction of 34.24 Mtce oil consumption and 18.75 million tons of carbon emission; natural gas share gains

4.7%, corresponding to increase of 129.78Mtce gas consumption and 69.73 million tons of carbon emission. On all accounts, the relative reduction of CO_2 emission in 2020 contributed to the energy mix optimization in comparison with that of 2000 is 40.92 million tons of carbon.

Table 3-2 Relative CO_2 mitigation owing to China's energy mix adjustment

	Energy mix in 2000 (%)	Energy mix in 2020 (%)	Energy saved in 2020 owing to the change of energy mix (Mtce)	Reduction (Mt-C)
Coal	67.0	62.29	-130.05	-91.90
Oil	23.6	22.36	-34.24	-18.75
Natural gas	2.5	7.20	+129.78	+69.73
Total			34.51	-40.92

Source: Estimated by this sub-subject based on the findings of "Scenario Analysis of China's Energy Demand 2000-2020".

4 Analysis and international comparison of China's CO_2 emission intensity per GDP

4.1 Status in quo of China's CO_2 emission intensity

Over the past two decades, along with the rapid economic development and industrial structure adjustment, China's energy intensity and CO_2 emission intensity per GDP has dropped down sharply. Compared with 1978, China's energy consumption intensity per GDP in 2001 dropped 91.26% in current price and 70.9% in 1978 constant price; meanwhile, the respective drop in CO_2 emission intensity per GDP was 91.46% and 71.54%. According to the statistics of World Bank, China's energy intensity per GDP in 2000 compared with 1978 dropped 68.8% in constant US$ price and 85.57% at PPP; meanwhile the corresponding drop in CO_2 emission intensity was 69.52% and 85.9%, respectively.

Table 4-1 Energy intensity and CO_2 emission intensity per GDP of China in 2000

Index	unit	In current RMB price	At current exchange rate of RMB to US$	At PPP and current exchange rate
Energy intensity per GDP	tce/10000 RMB(US$)	1.417	11.579	2.491
Carbon emission intensity per GDP	t-C/10000 RMB(US$)	0.949	7.756	1.669

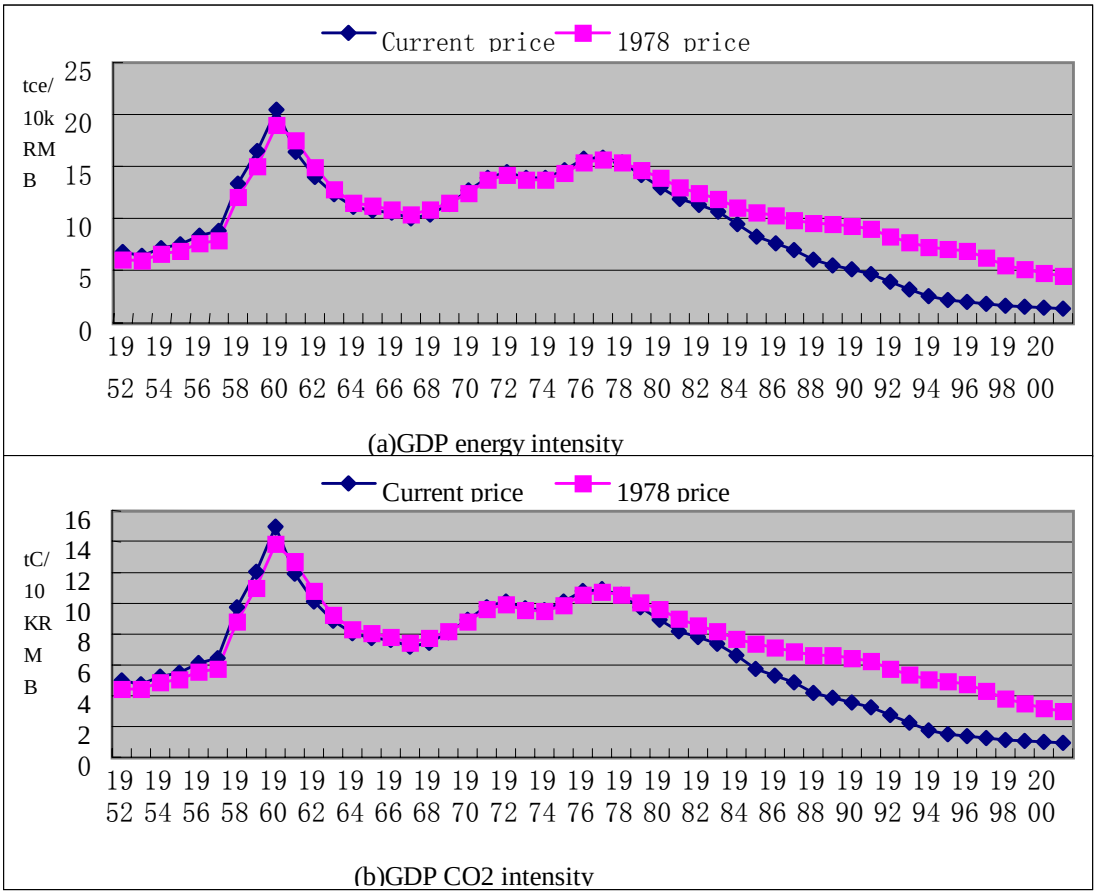

Figure 17 China's energy consumption intensity and CO_2 emission intensity per GDP calculated by RMB

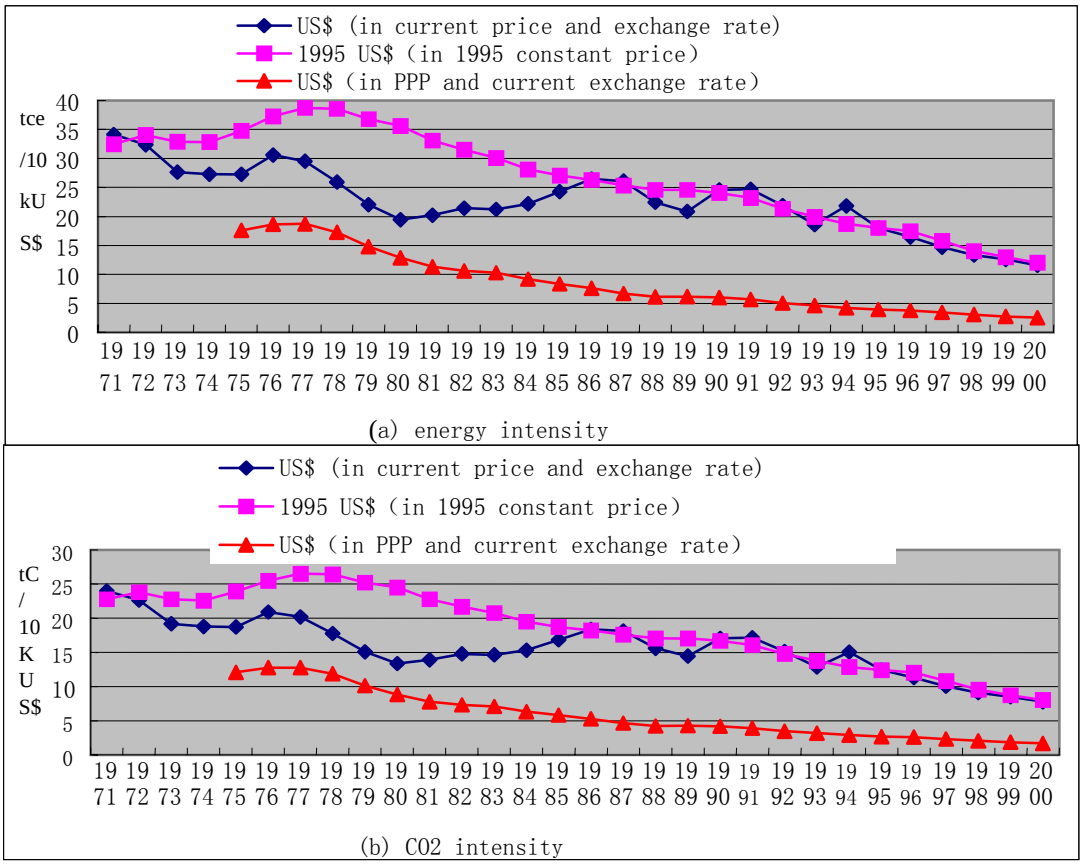

Figure 18 China's energy consumption intensity and CO_2 emission intensity per GDP calculated by US$

4.2 International comparison of China's CO_2 emission intensity per GDP

In the past two decades, China has maintained relative high speed of economic growth with very low energy consumption growth rate, and in consequence, realized the great drop of energy consumption intensity and CO_2 emission intensity per GDP. Nevertheless, as a developing country with huge population and low per capita GDP in process of industrialization, China's energy consumption intensity and CO_2 emission intensity per GDP are relatively higher than those of world industrialized countries (as shown in Figure 19).

According to the statistics of World Bank, China's energy consumption intensity in 2000 was 1.057 kgoe/US$ (kilogram oil equivalent per US$) at market exchange rate, beyond 3 times of world average and ranking 30th among the 121 countries and regions with statistics. China's CO_2 emission intensity per GDP in 1999 was 2.845 kg-C/US$, nearly 3 times of world average and ranking 23rd among the 177 countries and regions with statistics in the world.

However, it is worth noting that even though China's energy intensity and CO_2 emission intensity per GDP looks much higher than developed countries, they actually

correspond with China's current economic development stage. According to the 1999 standard of classification by World Bank, i.e. per capita GDP lower than US$ 760 for low-income countries, US$ 761-3030 for low-middling-income countries, US$ 3031-9360 for better-than-average-income countries and above US$ 9361 for high-income countries respectively, China is at low-middling-income stage with per capita US$ 790 in 1999 at market exchange rate. Correspondingly, China's energy intensity per GDP was 1.128 kgoe/US$, situated between the average value of 1.338 kgoe/US$ of low-income countries and 1.027 kgoe/US$ of low-middling-income countries. As energy mix in China is dominated by coal consumption, for this reason, China's energy intensity per GDP in 1999 was 2.845kg-C/US$ at exchange rate, higher than the respective average value of low-middling-income countries and low-income countries.

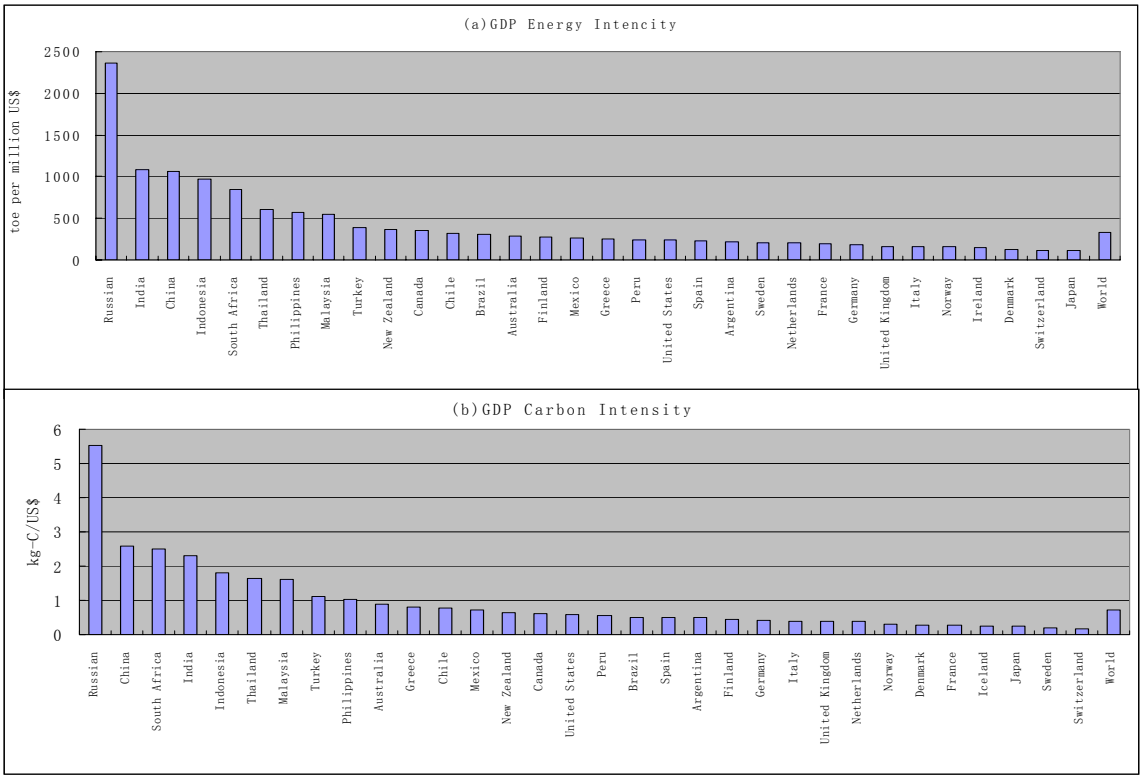

Figure 19 Energy consumption intensity and CO_2 emission intensity per GDP of world major countries' in 2000

Table 4-2 Comparison of energy consumption intensity and CO_2 emission intensity between world countries in 1999

	Per capita GDP (current US$ price)	Energy consumption intensity (toe/million US$)	CO_2 emission intensity (Kg-CO_2/ US$)
Least-developed countries		1033.943	0.603

Low-income countries	Lower than 760	1338.212	2.397
Lower-than-average countries	761～3030	1027.105	2.606
Middle-income countries	761～9360	723.011	1.817
Better-than-average countries	3031～9360	387.530	0.938
High-income country	More than 9361	202.016	0.464
OECD countries	27095	199.458	0.454
World average	5142	325.921	0.734
China	790.8	1128.05	2.845

If used the GDP data at PPP calculated by World Bank, China's energy intensity and CO_2 emission intensity per GDP in 1999 was 0.268kgoe/US$ and 0.675kg-C/US$, respectively, which approached to the United States' energy intensity and CO_2 emission intensity in the rough.

4.3 China's CO_2 emission intensity per GDP and development trend

According to the findings of "Scenario Analysis of China's Sustainable Energy Development and CO_2 Emission" recently finished by Energy Research Institute of NDRC (National Development and Reform Commission), it is probably for China to achieve the goal of quadrupling GDP while only doubling energy consumption, provided that China actuate her economic development by means of further technological progress and economic structure adjustment and succeed in energy conservation policy and sustainable energy development strategy. According to the 3 scenarios in "Scenario Analysis of China's Sustainable Energy Development and CO_2 Emission", China's per capita GDP in 2020 will be increased by 2.8 times on the basis of that in 1998 and reach 23,800 RBM. Meanwhile, per capita energy consumption may be 1.6~2.1 tce, still lower than 2.4tce of the world average in 2000

In the above-mentioned scenarios, China's energy intensity per million RMB in 2020 will be 88, 78 and 66 tce, respectively, decreasing by 50%, 55% and 62% compared with that in 1998. While CO_2 emission intensity per million RMB in 2020 will be 56, 49 and 38 tons of carbon, respectively, decreasing by 51%, 57% and 67% compared with that in 1998.

Table 4-3 Projection of energy and CO_2 emission intensity by "Scenario analysis of China's sustainable energy development and CO_2 emission"

	Energy intensity per GDP (tce/10000RMB)			CO_2 emission intensity per GDP (t-C/10000RMB)		
	1998	2010	2020	1998	2010	2020
Scenario 1	1.736	1.174	0.881	1.137	0.762	0.562
Scenario 2	1.736	1.099	0.784	1.137	0.706	0.492
Scenario 3	1.736	1.005	0.657	1.137	0.629	0.379

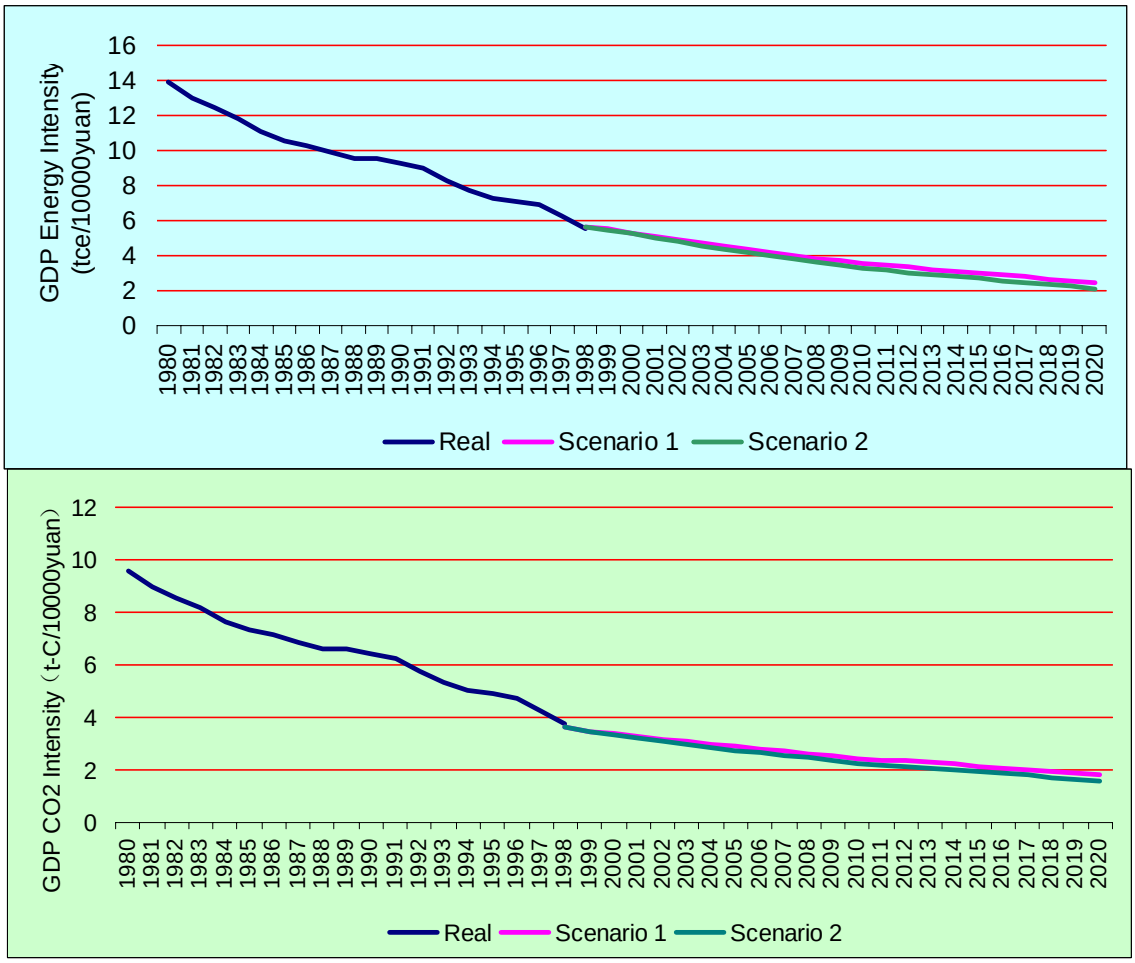

Figure 20 Developing trend of China's energy intensity and CO2 emission intensity per GDP, 1980-2020 (in 1978 constant price)

According to the findings of the above-mentioned scenarios, although it is probably for China to achieve the goal of quadrupling GDP while only doubling energy consumption, nevertheless, the dropping speed in energy intensity and CO_2 emission intensity per GDP will slow down. In other words, the decreased amount in energy intensity and CO_2 emission intensity during 1998-2020 will be relatively lower than that in the period of 1978-2000. Except in Scenario 3 which has very ideal assumption on utilization of low-carbon fuel and non-fossil fuel power generation, China's energy intensity and CO_2 emission intensity in 2020 will fall short of the projection in *International Energy Outlook 2003* published by EIA in 2003, whether in Scenario 1 or Scenario 2, even taking into account the policy of energy efficiency and alternative energy sources.

It is beyond doubt that China's energy intensity and CO_2 emission intensity will

step down gradually in the future, but surely remaining at the level corresponding with the developing stage that China come to. In the above-mentioned scenarios, China's per capita GDP in 2020 will come near to US$ 3000, still falling into the low-middling-income countries defined by World Bank. If calculated in 1998 constant price and exchange rate, China's energy intensity per million US$ will be 510.63, 454.41 and 380.8 toe respectively in the three scenarios in 2020, closing to the average level of better-than-average countries in 1999; Meanwhile, China's CO_2 emission intensity in 2020 will be 1.71, 1.49 and 1.15 kg-C/US$, respectively, falling short of the average level of better-than-average countries in 1999, but much better than that of middling-income countries.

5 China's Long-term Framework Strategy and Countermeasures on Global Climate Change

According to the provisions of UNFCCC and Kyoto Protocol, as a developing country, China has no obligation to reduce or control her GHG emission. Nevertheless, in the spirit of protection human environment and global environment, China would like to make contributions to global climate change by the means of carrying out sustainable development strategy, including energy conservation, improving energy efficiency, developing and utilizing non-fossil fuels such as hydropower and renewable energy sources, forest plantation and population control, etc.

5.1 China's Long-and-middle-term strategy framework on climate change

1. Guidelines

The guidelines for China's response to climate change include: (1) short-term countermeasures should be designed within the framework of the long-term strategy. The key is to ensure economic development contribute to the acceleration of sustainable development which require new approaches to improve energy efficiency and environmental protection; (2) comprehensive implementation of China's sustainable development strategy requires continued improvement of China's capacity to mitigate and adapt to the climate change in view of building up a concrete basis to reach the third goal of China's Three-Phase Strategy and to address global climate change issues.

2. Strategic objective

The overall objective of China's climate change strategy should be: (1) to considerably and effectively slowdown net GHG emissions, (2) to continuously build up the capacity for adapting to climate change, (3) to enhance public awareness of climate change issues, and (4) to play a leading role in scientific research on climate change.

3. Near term tasks

Near term task is to substantively reduce per GDP GHG emissions. This process will begin with accelerating sustainable development, which require new approaches to improve energy efficiency, the energy mix optimization, and environmental protection. The goal is to continuously enhance China's capacity to mitigate climate change and thus make a positive contribution to slow down global climate change.

4. Principles and positions

The United Nations Framework Convention on Climate Change (UNFCCC), as an important embodiment of the common wish and interests of the international community on the issue of global climate change, requires its parties to protect the climate system for the benefit of present and future generations of humankind on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. These fundamental principles and framework rules should be observed firmly. And the Convention recognizes that the largest share of historical and current global emissions of greenhouse gases has originated in developed countries. Developed countries have the major liability for addressing global climate change and decreasing the damage to developing countries. Therefore, the developed country parties ought to take the lead in addressing climate change and are able to do so as respects economy and technology, and the Kyoto Protocol has set quantitative and legal bindings for the developed country parties to reduce or control their GHG emissions. Considering the great differences in historical and current responsibility, capacity and per capita GHG emissions between developed and developing countries, it is not only unfair and unpractical to press developing countries into the commitments, but also breaks the fundamental principle of "common but differentiated responsibilities and respective capabilities".

China pays much attention on the issue of global climate change. In the past decade, although China has no concrete obligation on reduction under the Convention, China has made great efforts to mitigate climate change. Especially China's great achievement in raising energy efficiency, forest plantation and returning land for farming to forestry has reduced relatively great amount of GHG emissions, which has already been recognized by international community. However, it is worth noting that for these positive contributions to the Convention, China has paid heavy cost in economy and society such as mass unemployment.

China would like to cooperate with international community in global climate change within the framework of sustainable development. China has approved the Kyoto Protocol and participated actively in international cooperation on environment protection and sustainable development. Meanwhile, as a developing country, China has her first and overriding priority in social and economic development and poverty eradication. It is inevitable that, along with economic development and improvement of living standards, China's energy demand and GHG emissions will increase to a

certain degree in the future.

5.2 Recommendation to address global climate change

Global climate change is an issue with a very long term, which involves multitudinous scopes including society, economy, politics, diplomacy, science and technology. In order to address global climate change, international community has been initiating a series of environmental activities in wider and wider scopes, and these actions are getting faster and faster. China's efforts on global environmental issues are not only driven for global environmental protection, but also for a more favorable international environment for China's economic and social development. Therefore, China's countermeasures against global climate change should take full account of national long-term social and economic development and requirement. The effective execution of sustainable development strategy will not only contribute to China's social and economic development in the long term, but also promote global sustainable development and the actual implementation of UNFCCC and Kyoto Protocol.

5.2.1 Policy recommendation on China's CO_2 emission in the future

(1) China should fully recognize the inevitability of GHG emissions increase building an Overall Well-off Society in 2020.

China keeps a relatively high growth rate of economic development with low per capita energy consumption. This is largely due to the adjustment of energy and economic structures and energy efficiency improvements. However, China's energy demand will substantially increase and consequently CO_2 emissions will also inevitably increase in the coming 30 or 40 years because of continuous increase of the population. This will occur even though other energy demand driving forces such as urbanization, living standards, and per capita energy consumption are kept at the current low level.

According to the Energy Information Administration (EIA) of US Department of Energy, China's CO_2 emission from fossil fuel combustion was about 832 million tons of carbon in 2001 or 12.7 percent of the world's total, making China second largest emitter after the US. Compared with CO_2 emissions of 394 million tons of coal in 1980, the average annual growth rate has been about 3.6 percent. Nevertheless, China's per capita CO_2 emissions in 2001 were 0.65 tons carbon/person, only 61% of the world average. According to the goal of "Building a Well-off Society in a overall by 2020," China will maintain a high growth rate of economic development and consequently carbon emissions will increase. According to the projections from Scenario Analysis for China's Energy Demand in 2020, as well as that of EIA, China's CO_2 emissions from fuel combustion in 2020 will reach 1,700-1,800 million tons of carbon in 2020, still ranking second behind USA. But the contribution to the world total would increase to 18-19% bringing to China a more infamous image as a

big emissions country. In the scenario of Building a Well-off Society, China's CO_2 emission per capita in 2020 will be up to 1-1.23 tons of carbon, though still lower than the world average of 1.43 tons of carbon, gradually losing the advantage of low emission level per capita in international negotiations.

(2) China should fully recognize the pressure and challenge to reduce the CO_2 emission intensity per GDP.

Compared with other countries in the world, China's carbon emission intensity per GDP is at a very high level, even though it dropped by 52% during the period from 1990 to 2001, which to a certain extent passes as the excuse for some developed countries to press China to undertake emission reduction or emission control commitment.

Nevertheless, China's energy consumption intensity and CO_2 emission intensity per GDP will keep dropping as there is still relatively large room for China's industrial and product adjustment and technical energy conservation. According to the projection of EIA, China's CO_2 emission intensity per GDP will drop to 0.40 t-C/kUS$ by 47% from 2000 to 2020, with the fastest decreasing rate in the world. But there exist many uncertainties in those driving factors such as technological progress, economic development, industry adjustment, industrialization and urbanization, energy resources, and living style in the future. According the preliminary findings by "Scenario Analysis for China's Sustainable Energy Development and CO_2 Emission", by the end of 2020, China's CO_2 emission intensity per million RMB will be 56, 49 and 38 t-C respectively for the three scenarios in the research, decreased by 51%, 57% and 67% respectively compared with that of 1998. Even if China can achieve the goal of quadrupling GDP by only doubling energy consumption just like she did in the past years, due to the slowdown of annual decreasing rate in CO_2 emission intensity, the decreasing extent of CO_2 emission intensity for the period from 1998 to 2020 will still be lower than that for the period from 1978 to 2000 as well as lower than the estimation by EIA.

(3) China should fully recognize the impacts of United States' GHG Intensity Target on China.

GHG intensity index is a new conception advanced by the US, which has added new uncertainty to the validity and effectiveness of Kyoto Protocol. The GHG intensity index not only has made the issues of equity, share of burden and ways of commitment become the focal topics on international climate change negotiation, but also brought the negotiation goal under the Convention into the situation of dual systems or even multi-ways of commitment, which will certainly bring forward great impacts on the direction for the Convention's future development and to some extent on China's execution of the Convention. This new conception provides China the

choice of linking her politic willing of whether or not committed to reduce GHG emission intensity with the reduction goal that USA promised. It may also be regarded as an example and reference for China to take a certain commitment of emission limitation with proper way and at proper time.

5.2.2 Policy recommendations on addressing climate change within sustainable development framework

(1) China should fully recognize the importance of global climate change from the perspective of sustainable development strategy.

Firstly, effective implementation of the Convention and Kyoto Protocol will contribute not only to the world's sustainable development, but also to China's long-term goal of economic and social development. Secondly, the implementation of the Convention and Protocol can actively push technical progress for the whole world and create a brand-new sustainable development mode with low pollution and low resource consumption. Furthermore, the Kyoto Protocol has set quantitative, concrete and legal binding for the developed countries to reduce or control their GHG emissions, which can help to limit the virtual monopoly and partition of international energy resources among the minority of developed countries and provide more shares of resources for the majority of developing countries as well as a favorable conditions for China to utilize the world oil and natural gas resources. Therefore, China should fully recognize the positive effects of the Convention and Kyoto Protocol and take advantage of them to create a favorable international circumstance for China's Three Phase Strategy.

(2) China should establish the medium and long-term strategy to response to global climate change within sustainable development framework as soon as possible.

The guideline for China to response to climate change should be: The near-term countermeasures should comply with the long-term strategy. The core of the idea is to ensure economic development with the fundamental starting point of accelerating the sustainable development via the breakthrough of energy efficiency improvement and ecosystem construction; The principle is to perseveringly implement China's sustainable development strategy in all aspects and continuously enhance China's capacity of mitigating and adapting to climate change for the purpose of building up a concrete basis for the third goal of China's Three-Phase Strategy as well as for global climate protection. The overall objective of China's climate change strategy should be: to slowdown the growth rate of GHG net emission remarkably and effectively, to build up the capacity of adapting to climate change continuously, to enhance public awareness on climate change, and to strive for the leading level of research on the science of climate change.

(3) China can take an active role in global climate protection via sustainable

development policies and measures.

In the spirit of protecting global environment, China should take full advantage of the opportunities introduced by global climate change issues and intensify the implement of policies and measures to promote the sustainable development under the prerequisite of not impeding China's long-term social and economic development. In order to slowdown CO_2 emission to the ultimate potential, China should take full advantage of foreign direct investment to expedite the progress of technology development and transfer, to strengthen economic structure adjustment, and to improve energy efficiency and mix. The other option is to fully utilize the forestry's huge CO_2 absorbing capacity by returning farmland to forestry, strengthening afforestation and reforestation, forbidding excessive deforestation, etc.

(4) China should carry on to further control population growth rate, to enhance public awareness of global climate protection, and to build up a new style of living and consumption with lower GHG emissions.

The huge population and its rapid growth rate have brought oppressive pressure on China's energy consumption and CO_2 emission. Therefore, China should carry on the basic national policy of family planning to further control the population growth rate. In the meantime, China should make use of all kinds of media vehicles such as television, newspaper, books, periodicals, and videos to enhance public awareness of resources and environment and sense of participation in global climate protection, and to guide people to build up a new style of living and consumption with lower GHG emissions. For example, to use high efficient household electric appliances, to make full use of public transport infrastructures, to purchase and use recycled paper, and to dispose recoverable domestic wastes by sort.

(5) China objects to the proposal that makes use of the concept of responding climate change under the framework of sustainable development as a request for developing countries to be committed to the climate change obligation of reducing or controlling their GHG emissions.

The idea of response to global climate change under the framework of sustainable development, not only challenges to the exiting social economic development mode which highly relies on natural resources to develop material civilization, but also show clearly the direction for the coming negotiation under the Convention. However, the meaning of sustainable development is not the same for countries at different developing phases. With respect to developing countries, their primary priority is development and their CO_2 emission will inevitably increase in the future. At present, developing countries pay more attention to the challenge of meeting the basic development requirement instead of global climate protection. As to most developing countries, a relative easy step for them is to follow a more sustainable development mode starting from their development goal as well as the consideration of climate change. But this does not necessarily mean the decrease of

GHG emissions, nor can it be an excuse of developed countries for urging developing countries to be committed to reduce or control their GHG emissions in the near future.

5.2.3 Policy suggestions on China's participation in CDM activity

(1) Applying the finance additionality principle of CDM project to improve the utilization efficiency of foreign investment

Firstly, China should urge developed countries to observe the COP principles concerning CDM investment, which is the precondition to guarantee the additionality of CDM fund. Secondly, China should explicitly request the developed countries to invest CDM projects with public fund additional to ODA or other funding mechanisms in the Convention, at least the public fund for the CDM projects should be additional to the ODA which now reaches 0.7% of their GDP. Thirdly, China requires that the share of private investment in CDM project should be higher than that in common commercial project, which is very important to minimize the incremental cost of GHG emission mitigation. Otherwise, CDM projects will be a sheer identity change of common commercial projects.

(2) Making use of the technology additionality principle of CDM project to promote international technology transfer

Firstly, China should require the CDM Executive Board to establish the standard of advanced technology for some sectors with large GHG mitigation potential such as thermal power sector, to guarantee the technological consistency for the same type of CDM projects in different countries or regions as well as to avoid the phenomenon that even the outdated technology in developed countries can yield some emission reduction in underdeveloped countries. This kind of CDM standard of advanced technology can help to guarantee those technologies with actual GHG mitigation effect to be transferred to developing countries via CDM projects. Secondly, as CDM projects are the bilateral projects between parties, the technological additionality of CDM project requires the developed countries not only to transfer public technology via CDM projects, but also require them to implement all kinds of policies and measures to stimulate the private companies to transfer those exclusively-owned technologies for CERs that can not be transferred by normal commercial means or the companies are not willing to transfer under other conditions. Therefore, in order to guarantee technology additionality of CDM projects, developed countries should implement some effective policies and measures and build up concrete institute to promote the relevant technology transfer and to create a sound environment for technology transfer.

(3) Strengthening the scientific assessment of CDM project to promote sustainable development

In the decision preface concerning CDM project at COP7, it was restated that the

host party is entitled to judge whether a CDM project can contribute to the national sustainable development, which is a significant principle for CDM. Therefore, China should start from the real situation and integrate with the sustainable development assessment index system including economic sustainability, eco-environment sustainability and social sustainability to judge a CDM project whether or not can contribute to China's sustainable development, especially to China's sustainable development in energy sector. To speak more specifically, China can assess a CDM project in energy sector according to the following aspects: increasing economic output, increasing effective energy supply, advanced technologies, reduce local pollution, increasing employment. The assessment index system can be: output/CERs, effective energy/CERs, CERs/emission baseline, pollutant emission/CERs, employment/CERs.

(4) Strengthening the institutional and capacity building, and making preparations for CDM participation

At current stage, participation in CDM project is an important agenda for China to participate international cooperation on global climate change. Therefore, China should make preparation in all aspects such as institution, management, capacity building and project assessment for CDM participation. Since CDM participating countries are required to designate a national CDM authority to execute the government responsibilities as CDM parties, China should establish a special CDM administrative authority under the leadship of National Coordination Committee on Climate Change. Considering that some governments have already implemented a certain procedure like bidding and tendering to carry out the CDM project, China's authorities concerned with CDM should also take actions to assess the potential CDM projects based on China's structure adjustment and West Region Development Strategy, and establish a concrete CDM project database which can act as a reference and menu of CDM projects for the negotiators.

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