PROSPECT OF ENERGY CONSUMPTION AND CO_2 EMISSION IN CHINA

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Abstract

China has made great achievements in economic and social development since 1980s. With the continuous growth of economy and population, higher energy intensity and special energy structure will cause the continuous growth of primary energy consumption and CO_2 emission in the next 20-30 years in China. Based on the projection of population that the UN offered and GDP growth that Energy Information Administration provided, energy consumption in next 20 years in China is forecasted in this paper. Coal-based energy consumption structure decided the inevitable growth of CO_2 emission in China in the future. According to historical data of 4 indicators related with CO_2 emission, more than 50 countries are classified to 4 sorts through K-means cluster analysis, which offers reference for scenario analysis of CO_2 emission in China in the future.

In high-emission and low-emission scenario, CO_2 emission is forecasted respectively. Finally energy strategy option from Chinese government is discussed. China is actively adjusting the economic and energy structure, comprehensively promoting energy conservation, controlling environmental pollutants emission effectively, and promoting the coordinated development of energy and environment.

Riassunto

La Cina, a partire dagli anni ’80 del secolo scorso, ha conseguito un eccezionale sviluppo economico che ha portato il Paese alla ribalta del mondo intero. L’accrescersi della variabile demografica, le maggiori esigenze della popo-

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lazione e l'alta intensità energetica saranno causa, nei prossimi 20-30 anni, di un ulteriore accrescimento della domanda e dei consumi energetici che, tenuto conto della struttura energetica del Paese, potranno influire sulla entità delle emissioni di CO_2.

Sulla base delle proiezioni demografiche fornite dalle Nazioni Unite e sulle previsioni di crescita del PIL effettuate dal Energy Information Administration di Washington nel lavoro viene determinato, per i prossimi 20 anni, il consumo di energia primaria della Cina.

Secondo i dati storici di 4 indicatori connessi con le emissioni di CO_2, più di 50 paesi sono classificati in 4 tipologie facendo ricorso alla "K-means cluster analisis" , che fornisce gli scenari di riferimento per la determinazione delle emissioni di CO_2 in Cina. Vengono quindi prospettati due scenari di emissione di CO2: alta e bassa.

Sono quindi discusse le opzioni a disposizione del Governo cinese.

Key words: China; energy consumption; CO_2 emission; scenario analysis; energy strategy

Introduction

As we know, China has made great achievement in economic and social development and is playing an increasingly important role in the world economic stage since 1980s.

From 1980 to 2005, the average annual growth rate of GDP was 10.7%. As we have mentioned before (1), energy is one of key roles in social and economic development process.

In China, energy consumption per capita increased from 0.90toe/capita to 1.32toe/capita between 2001 and 2005, the growth rate is 46.7%. For energy intensity in 2005, the level in China is 3.9 times of the United States, 5 times of Italy and 7.9 times of Japan, high energy intensity has become one of important bottlenecks restricting development of China, and with the coal-based energy structure now and in a long term, China has become the world's second-largest source of carbon dioxide emission behind the United States.

It can be foreseen that in the next 20-30 years, Chinese economy will continue to grow and at the same time there is a necessity for China to control the CO_2 emission because of the signature on the "Kyoto protocol".

Prospect of energy consumption in the future

With the fast growth of economy and higher energy intensity, it is inevitable for China to consume more and more energy. Besides economy growth, population growth is another key driver for energy demand. According to the projection of the UN, the population of China will increase from 1.3 billion in 2005 to 1.45 billion in 2025.

Although the share of Chinese population will decrease gradually from 20.3% to 18.2% (Table 1), it is out of doubt that China will play a very important role in international energy demand.

TABLE 1

HISTORY AND PROJECTION OF THE POPULATION OF CHINA (1950-2025) (2)

(Unit: thousands)

Year	World	China	Share (%)
1950	2535093	556924	22.0
1960	3031931	660739	21.8
1970	3698676	834871	22.6
1980	4451470	1004168	22.6
1990	5294879	1155146	21.8
2000	6124123	1277065	20.9
2005	6514751	1320509	20.3
2010	6906558	1359422	19.7
2015	7295135	1396851	19.1
2020	7667090	1429823	18.6
2025	8010509	1454623	18.2

At present, because of big population, primary energy per capita in China is much lower than that of developed countries, that is 1.32 toe/capita in 2005, contrasted with 5.9 toe/capita in developed countries and 1.8 toe/capita in the world. According to our former study (1, 3), we can regard 1.5 toe/capita is the minimum quantity for all the peoples of the world are entitled to so that an equal average life expectancy at birth is guaranteed. Indeed this value represents the quantity beyond which additional doses of

(3) Then in the far future, the second step to be pursued is to achieve the threshold of 3 toe per capita per year, which is linked to the achievement of lower infant mortality rate in the first year of life (In 2005, infant mortality rate in China is 23‰ contrasted with the value lower than 5‰ in developed countries).

energy availability do not affect the average life expectancy at birth, which is 80 years (the average life expectancy at birth in China is 72 years old in 2005). It should be the essential first step for China to pursue an average level of energy consumption per capita equal to 1.5 toe (3).

Then, with the rapid growth of GDP and population, and the necessity to increase the level of primary energy per capita, what is the future of energy consumption in China?

TABLE 2

HISTORY AND PROJECTION OF GDP GROWTH RATE

Unit: %

Country	History		Projection			Average
	1980-2005	2006	2007	2007-2015	2015-2030	2004-2030
China	9.8	10.5	9.5	7.2	5.4	6.5

As we have studied (3), there is a correlation between GDP per capita and energy consumption per capita, the fitted regression equation is: $G=1694.6E^{1.2728}$, in which G is GDP per capita and E is primary energy consumption per capita. We can get the projection of GDP (2007-2025) of China according to the GDP growth rate projection (Table 2) that the Energy Information Administration in Washington provided (4), then with the population projection of the United Nations, we get the GDP per capita projection.

So with the correlation we got in Figure 3, the projection of total primary energy consumption (TPEC) per capita and total energy consumption and corresponding energy intensity in China is finally obtained (Table 3).

According to our study (3), the primary energy consumption in 2025 will be 8.0 Gtoe in developed countries and 10.1 Gtoe in developing countries, and a world total of 18.1 Gtoe. We can see the big proportion of Chinese energy consumption in the world in future (16.6 % of the world total primary energy consumption in 2025).

As to energy intensity, although decreasing continually, energy consumption per thousand GDP in China in 2025 will be still far higher than that of Japan, UK and Germany in 2005 and similar with Canada's level at present (Table 4).

TABLE 3
PROJECTION OF ENERGY CONSUMPTION OF CHINA ON THE BASIS OF GDP GROWTH (2005-2025)

Year	GDP (billion $)	Population (billion)	GDP per capita (2000 $)	TPEC per capita (toe)	TPEC (Gtoe)	Energy intensity (toe/ thousand 2000 $ GDP)
2005	2098	1.32	1589	1.32	1.7	0.89
2010	3127	1.36	2300	1.29	1.8	0.58
2015	4427	1.40	3170	1.56	2.2	0.50
2020	5759	1.43	4028	1.80	2.6	0.45
2025	7491	1.45	5150	2.08	3.0	0.40

TABLE 4
ENERGY INTENSITY IN SOME DEVELOPED COUNTRIES IN 2005

Country	Australia	Canada	Germany	Japan	UK	USA
Energy intensity	0.30	0.44	0.18	0.11	0.15	0.23

Scenario analysis of CO_2 emission in China in future

Cluster analysis

Coal-based energy consumption structure decides the inevitable growth of CO_2 emission in China in next period of time. In addition to the structure of energy consumption, CO_2 emission is also related with several other factors. First is the stage of economic development, which including the level of economic development and the structure of industrial development, they are closely related to the needs and type of energy, and then affect the level of CO_2 emission. The second is the energy efficiency of industrial sector. The lack of advanced technology and the existence of large number of lagging technologies make Chinese energy efficiency far behind the advanced international level, which leads to the massive consumption of fossil energy and eventually generates large carbon dioxide emission. For different industrial types, energy consumption intensity is very different.

According to the study of Wei Bao-ren (5), there is notable correlation between industrial structure and regional urbanization level. The progress of urbanization is also a process of industrialization, which reflects the mode of regional socio-economic development to some extent.

Here, we select four indicators: the proportion of coal in primary energy consumption, carbon dioxide emission intensity, GDP per capita and the urbanization level, to reflect the characteristics of factors mentioned above. Taking five years as a stage, we make "K-means cluster analysis" of historical data (from 1980 to 2005) of the 4 indicators of more than 50 countries, to summarize the different modes of development and take them as the reference of China's future energy consumption and CO_2 emission scenario. The analysis results are shown in Table 5 - Table 8.

TABLE 5

CLUSTER MEMBERSHIP

1	2	3	4
Algeria	Argentina	Australia	China
Bangladesh	Brazil	Austria	India
Egypt	Canada	Denmark	
Indonesia	Chile	Finland	
Pakistan	Colombia	France	
Philippines	Korea, South	Greece	
Portugal	Mexico	Japan	
Thailand	New Zealand	Netherlands	
	Peru	Norway	
	Spain	Switzerland	
	Sweden	Turkey	
	United Kingdom	United States	

The Table 6 shows modified variable central value of historical data after the K-means algorithm iteration.

The Table 7 and the Table 8 show the result of variance analysis of the cluster distance of different type, the probability values <0.001, reflecting the good clustering result. Thus 34 valid samples are classified to four sorts, 8 samples in the first, 12 samples in the second, 12 samples in the third and 2 samples in the fourth (Table 5 and Table 8).

Because of big population, lower economic development level and similar energy structure, China and India are classified to one sort. For the other 3 sorts, the first sort is characterized by lower economic development level and urbanization level and higher CO_2 emission intensity, the second

and third sort represent the more advanced level of the 4 indicators, in which the third is characterized by much higher urbanization level, economic development level and much lower CO_2 emission intensity.

In order to know further more about the factors related with CO_2 emission, on the basis of the data used in cluster analysis, we get the Pearson Correlations index in Table 9.

TABLE 6

FINAL CLUSTER CENTERS

Variables	**Cluster**			
	1	2	3	4
coal% 1980	2.54	12.82	17.61	64.40
coal %1985	5.63	14.03	20.55	66.79
coal %1990	7.75	12.57	19.97	66.55
coal %1995	7.96	10.24	18.10	65.97
coal %2000	9.33	9.71	17.64	60.92
coal %2005	10.69	9.98	16.99	62.61
Urbanization 1980	30.88	73.67	65.83	21.50
Urbanization 1985	34.13	76.00	67.42	23.50
Urbanization 1990	37.63	78.25	68.92	26.50
urbanization 1995	40.13	79.58	70.08	29.00
urbanization 2000	42.50	81.08	71.33	32.00
urbanization 2005	45.25	82.33	72.83	35.00
CO_2 intensity 1980	1.05	.71	.64	4.92
CO_2 intensity 1985	1.05	.66	.57	4.12
CO_2 intensity 1990	1.14	.62	.55	3.58
CO_2 intensity 1995	1.20	.61	.54	3.03
CO_2 intensity 2000	1.21	.59	.51	2.28
CO_2 intensity 2005	1.19	.56	.49	2.31
GDP per capita 1980	2	9	21	0
GDP per capita 1985	2	9	23	0
GDP per capita 1990	2	10	26	0
GDP per capita 1995	2	11	27	1
GDP per capita 2000	3	13	31	1
GDP per capita 2005	3	13	27	1

TABLE 7

VARIANCE ANALYSIS

Variables	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
coal %1980	2087.284	3	105.591	30	19.768	.000
coal %1985	2080.605	3	137.867	30	15.091	.000
coal %1990	1978.378	3	122.450	30	16.157	.000
coal %1995	1986.051	3	99.707	30	19.919	.000
coal %2000	1628.505	3	97.638	30	16.679	.000
coal %2005	1671.488	3	99.908	30	16.730	.000
urbanization 1980	4076.803	3	116.524	30	34.987	.000
urbanization 1985	3917.560	3	93.876	30	41.731	.000
urbanization 1990	3670.741	3	79.785	30	46.008	.000
urbanization 1995	3456.087	3	81.157	30	42.585	.000
urbanization 2000	3265.953	3	89.253	30	36.592	.000
urbanization 2005	3018.212	3	97.394	30	30.990	.000
CO_2 intensity 1980	11.114	3	.733	30	15.170	.000
CO_2 intensity 1985	7.630	3	.346	30	22.050	.000
CO_2 intensity 1990	5.727	3	.247	30	23.213	.000
CO_2 intensity 1995	4.097	3	.114	30	35.845	.000
CO_2 intensity 2000	2.414	3	.094	30	25.573	.000
CO_2 intensity 2005	2.550	3	.100	30	25.442	.000
GDP per capita 1980	737.690	3	51.077	30	14.443	.000
GDP per capita 1985	882.313	3	61.192	30	14.419	.000
GDP per capita 1990	1100.233	3	77.942	30	14.116	.000
GDP per capita 1995	1180.072	3	79.404	30	14.862	.000
GDP per capita 2000	1515.207	3	98.988	30	15.307	.000
GDP per capita 2005	1143.546	3	79.927	30	14.307	.000

TABLE 8

NUMBER OF CASES IN EACH CLUSTER

Cluster	1	8.000
	2	12.000
	3	12.000
	4	2.000
Valid		34.000
Missing		25.000

TABLE 9

CORRELATIONS ANALYSIS

	Proportion of coal	GDP per capita	Urbanization	CO_2 emission intensity
Proportion of coal	1.000	-.126	-.211	.575
GDP per capita	-.126	1.000	.531	-.643
urbanization	-.211	.531	1.000	-.656
CO_2 emission intensity	.575	-.643	-.656	1.000

The Table 9 shows the obvious negative correlation between GDP per capita, urbanization level and CO_2 emission intensity, the correlation coefficient is -0.643 and -0.656 respectively.

Scenario analysis

(A) High-emission scenario

In high-emission scenario, we suppose the energy structure in China will not change till 2025. According to the forecast of primary energy consumption in Table 3, taking the average level of energy structure in China between 2000 and 2005 (Table 10) as the energy structure in the next

20 years, we get the projection of different type of primary energy consumption (Table 11), then based on CO_2 emission coefficient of different energy type (Table 12), we get CO_2 emission in high-emission scenario (Table 13).

TABLE 10

HISTORY OF PRIMARY ENERGY CONSUMPTION STRUCTURE IN CHINA

Unit: %

Year	Oil	Natural Gas	Coal	Nuclear	Hydroelectricity
2000	23.1	2.2	69.0	0.4	5.2
2001	22.8	2.4	68.1	0.4	6.3
2002	23.4	2.4	67.5	0.5	6.2
2003	22.1	2.4	69.4	0.8	5.2
2004	22.4	2.5	68.7	0.8	5.6
2005	20.9	2.6	69.9	0.8	5.7
Average	22.5	2.4	68.8	0.6	5.7

TABLE 11

PRIMARY ENERGY CONSUMPTION STRUCTURE OF HIGH-EMISSION SCENARIO

Unit: Mtoe

Year	Total primary	Oil	Natural Gas	Coal	Nuclear	Hydroelectricity
2005	1,400	315	33.6	963.2	8.4	79.8
2010	1,800	405	43.2	1238.4	10.8	102.6
2015	2,800	495	52.8	1513.6	13.2	125.4
2020	2,600	585	62.4	1788.8	15.6	148.2
2025	3,000	675	72	2064	18	171

TABLE 12

CO_2 EMISSION COEFFICIENT OF DIFFERENT ENERGY TYPE (6)

Unit: tc/tce

Energy type	Coal	Oil	Natural gas
emission coefficient	0.76	0.59	0.45

TABLE 13

CO_2 EMISSION OF HIGH-EMISSION SCENARIO

Year	**Total primary energy (Mtoe)**	**CO_2 emission ($MtCO_2$)**
2005	1,400	5,100
2010	1,800	5,770
2015	2,800	7,053
2020	2,600	8,335
2025	3,000	9,617

(B) Low-emission scenario

In low-emission scenario, we suppose China will develop as a similar mode of the third sort in "K-means cluster", which is a development mode of higher economic development level with a lower CO_2 emission intensity. Considering the similar energy structure trend (decreasing but relative higher proportion of coal in total primary energy consumption) and developing characteristic (relative faster industrialization and urbanization process, faster growth rate of development, close relation between research and industry, relative higher population density etc.), we suppose the developing mode of Japan in the past 20 years can be taken as a reference for the developing mode of China in the next 20 years to be the low-emission scenario of China. According to the regression curve of GDP per capita and CO_2 intensity based on Japanese historical data and forecast of GDP in China (Figure 1), we get prospect of CO_2 emission intensity in China and then CO_2 emission in low-emission scenario (Table 14).

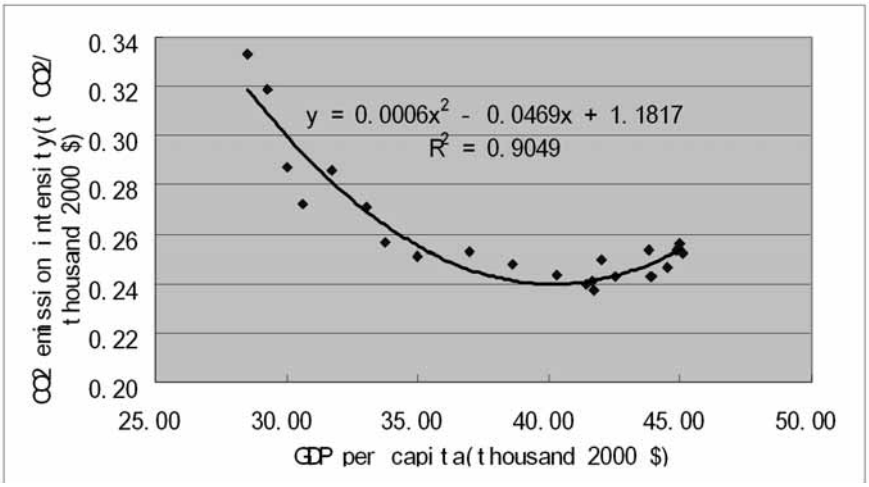

Fig. 1 - Economic development and CO_2 emission mode of Japan

CO_2 emission intensity
(t CO_2) thousand 2000 $)

TABLE 14

CO_2 EMISSION OF LOW-EMISSION SCENARIO

Year	GDP per capita (thousand 2000 $)	CO_2 mission intensity (t CO_2/ thousand 2000 $)	CO_2 emission ($MtCO_2$)
2010	2.30	1.08	3,368
2015	3.17	1.04	4,600
2020	4.03	1.00	5,774
2025	5.15	0.96	7,162

Table 15 shows the prospect of CO_2 emission in China in high and low emission scenarios.

In high emission scenario the increasing of population is considered, but the technology progress and change of energy structure in the future are not considered.

TABLE 15

SCENARIO ANALYSIS OF CO_2 EMISSION

Unit: $MtCO_2$

Year	High-emission	Low-emission
2005	5100	
2010	5,770	3,368
2015	7,053	4,600
2020	8,335	5,774
2025	9,617	7,162

Energy strategy option from Chinese government

As a responsible developing country, China attaches great importance to environmental protection and global climate change. Taking environmental protection as a basic national policy, Chinese government signed the "United Nations Framework Convention on Climate Change," set up a national coordinating institution on climate change measures, submitted a "climate change initial national communications," established the "clean development mechanism project management approach ", and has taken a series of policies and measures on protecting environment and addressing climate change. China is actively adjusting the economic and energy structure, comprehensively promoting energy conservation, controlling environmental pollutants emission effectively, and promoting the coordinated development of energy and environment (7).

To optimize energy consumption structure

Coal-based energy structure in China is determined by Chinese resources conditions. Characteristics of the energy resources with more coal and less oil determine coal as the main force of energy consumption in China in the long term. The share of oil, natural gas, hydropower and other cleaner energy in the total energy consumption will gradually increase. As a whole, energy consumption structure will be transferred gradually from a single structure with coal to a multiple structure with coal, hydropower, nuclear power, petroleum, natural gas, wind energy, solar energy etc., and the energy consumption structure will be constantly optimized (8).

(A) Exhaustible sources

♦ Nuclear power

Nuclear fuel resources are mainly used for nuclear reactors to generate electricity. Nuclear power industry of China is still in beginning stage at present, the total nuclear power generation accounts for only about 1% of the total country, and in the next 10 years it will reach around 2% (8). The proven uranium reserves in China are in the top 9 (reserves of more than 100,000 tons) in the world, in the long term, Chinese nuclear power industry has broad prospects of development.

♦ Oil and natural gas

China will continue to implement the policy of oil and natural gas exploited together, to steadily increase the output of crude oil, and to enhance natural gas production. However, because of the shortage of global and Chinese oil resource and the rise of oil prices, the proportion of oil consumption will decline in the future. Exploitable reserves of conventional natural gas resources in China is about 13.3×10^{12} m^3 at present, it can be foreseen in the next few decades, natural gas proved reserves will grow rapidly. While Chinese natural gas consumption accounts for only 2.8% of total energy consumption, therefore, natural gas has good prospects for development in China, and should be developed in large scale and be one of important energy strategies of China (8).

(B) Renewable sources

Renewable energy is a prior development area of China's energy strategies. Renewable energy development and utilization plays an important role in increase of energy supply, improvement of energy structure and promotion of environmental protection, and is a strategic choice to resolve conflicts of energy supply and demand and to achieve sustainable development.

In 2005, the amount of renewable energy utilized in China is about 1.66×10^8 tce which is 7.5 % of the total primary energy consumption. China has issued a "long-term development planning of renewable energy" in which the target is proposed that renewable energy consumption accounts 10% of total in 2010 and 15% in 2020 (9).

According to resources potential, technological conditions and market demand of various renewable energy, the important development areas proposed in "renewable energy and long-term development plans" in 2010 and 2020 include hydropower, biomass energy, wind power, solar energy, geothermal energy.

♦ Hydraulics

China has abundant hydropower resources, the theoretical reserves are 694 million kilowatts and 2.92 trillion kWh. Technological development capacity is 542 million kilowatts and 2.47 trillion kWh.

Taking into account distribution of resources, development and utilization conditions, economic development level and electric power market demand etc., the emphases of China's hydropower construction in the future are focused on Jinsha River, Yalong and Dadu River, Lancang River, Nujiang River and the upper stream of the Yellow River. At the same time, small hydropower resources should be further developed in rich hydraulic resources region. China has rich small-hydropower resources, the technological development volume is 100 million kilowatts (9).

At present, small hydropower has covered 40% of the country's land area, provided electric power for 1/ 3 County and 300 million population of China. China has become the world's largest country with small hydropower. According to experts' prediction, by 2020, China's small hydropower will be developed to the level with installed capacity of 50 million ~ 55 million kilowatts and generating capacity of 160 billion ~ 170 billion kWh.

♦ Wind energy

China has huge potential for the development of wind energy, exploitable wind energy reserve is about 10 million kilowatts (10), although wind power installed capacity increased rapidly from 4.1 MW in 1990 (11) to 1,260 MW (12) in 2005, the exploitation rate of wind energy resources still remains at a very low level.

In the future, China will make full use of wind energy resources to promote technological progress and industrial development of wind power through large-scale wind power development and construction

♦ Geothermal energy

China is a country with rich geothermal resource, accounting for 7.9% of the global geothermal resource (13). Chinese geothermal resource is mainly middle and low temperature, 2900 geothermal resources spots have been found, of which 1,600 have been developed and used for heating, bathing, etc.. In 2000, the direct use of Chinese geothermal resources (proven reserves of 3.16 billion tons of standard coal) is 600,000 tce, the utilization rate is less than 0.02%. According to the Chinese renewable energy planning, the development and utilization of geothermal energy will be actively promoted. The utilization of geothermal energy is planned to 4 million tce in 2010 and 12 million tce in 2020.

♦ Waste biomass

China has abundant biomass resources. At present, biomass production for direct combustion is 219 million tce in China, 7.63 million methane tanks are used to produce 2.6 billion m^3 gases. More than 1000 methane projects using industrial organic wastewater, livestock manure and agricultural waste are constructed to produce 1 billion m3 gases.

Chinese government and relevant departments attach great importance to the use of biomass energy sources. Research on biomass energy utilization technology is continuously put in national four "five-year plan" as key scientific and technological projects. Biomass power, methane gas, biomass solid fuel and liquid fuel are determined to be the priorities of the biomass energy in the future in the national renewable energy long-term planning.

To develop low-carbon technology and participate in international emission-reduction cooperation

♦ Cleaner coal technology

Cleaner coal technology (CCT) refers to the new technologies aiming at reducing pollutants emission and improving the coal utilization efficiency in the process of development and use of coal.

Due to the important position of coal in Chinese energy consumption, coal will still be the major primary energy in China for a long period of time. Promotion of cleaner coal technology is of great significance for improvement of Chinese energy efficiency and reduction of carbon emission and other pollutants emission in China.

At present the more mature cleaner coal technologies include: separation coal, power coal, coal-water slurry, coal gasification, coal liquefaction, cleaner combustion and power generation technologies. Cleaner coal technologies included in Chinese long-term development planning include: large-scale supercritical conventional steam generating units (USC); gasification combined cycle generating units (IGCC); pressurized fluidized bed combustion combined cycle power generation system (PFBC), circulating fluidized bed power plant (CFBC).

The future development of cleaner coal technologies in China will make full use of international technical resources, integration of self-development and introduction. Mature cleaner coal technologies should be introduced into China to reduce the enormous pressure on the environment (14).

♦ CO_2 capture and storage technology (CCS)

In order to inhibit the trend of global warming it is necessary to reduce CO_2

emission. However, majority of CO_2 emissions are caused by the use of fossil fuels. At this stage it is not realistic to eliminate all the energy causing CO_2 emission. It is an urgent need to find a mode capable to reduce CO_2 emission without compromising the living standards.

A new assessment report released by Intergovernmental Panel on Climate Change (IPCC) shows, capture and storage of CO_2 in power plants before releasing into atmosphere can mitigate climate change effectively (15). Large quantity of studies show that in the next 100 years CO_2 capture and storage technology (CCS) will reduce the cost of inhibiting climate change by 30% or even more. Now CO_2 capture and storage technology has been more and more mature, and three CSS projects have been operated in Canada, Algeria and Norway.

As the world's second largest carbon dioxide emission country behind the United States, implementation of CCS technology in China is of great strategic significance, Chinese government has been actively seeking for technical cooperation opportunity of CCS technology. In December 2007, the first project "3,000 tons of carbon dioxide capture in coal-fired power plants" in China was started in Huaneng Thermal Power Plant, which will decrease carbon dioxide emission greatly. Designed recovery rate of carbon dioxide will be more than 85%, and the recycling capacity of carbon dioxide will be 3,000 tons.

♦ Implementation of CDM

According to the "United Nations Framework Convention on Climate Change" and the "Kyoto Protocol", as a developing country, China can participate project-based carbon emission trading. Lower energy efficiency and rapid growth of energy demand in China determine the great potential for China to implement CDM project.

Development of CDM project in China is facing an unprecedented good opportunity, many developed countries are regarding China as one of important strategic objects to carry out CDM projects and realize their target of "Kyoto Protocol". Until August 2007, the National State Development and Reform Commission in China approved a total of 737 CDM projects, the annual emission reduction provided by China is more than 40% of the world. China will continue to play an important role in global carbon market.

Conclusion

As we have seen China has made great achievements in economic and social development since 1980s and it can be foreseen that in the next 20-30 years, Chinese economy will continue to grow. That means the demand and energy consumption in China will grow increasingly.

According to projection, the primary energy consumption in China in 2025 will be 3 Gtoe, which is contrasted with 8.0 Gtoe of primary energy consumption in developed countries and 10.1 Gtoe in developing countries in 2025and China will play a very important role in international energy demand in the future.

In scenario analysis of CO_2 emission, CO_2 emission in high-emission and low-emission scenario is forecasted respectively (7,162~9,617 Mt CO_2). Large CO_2 emission now and in the future will bring great challenge to Chinese government.

As a responsible developing country, Chinese government attaches great importance to environmental protection and global climate change. Chinese government is actively optimizing energy structure, comprehensively promoting energy conservation and controlling environmental pollutants emission effectively through the implementation of low-carbon technology and participation of international emission-reduction cooperation to promote the coordinated development of energy, environment and economy.

So, as stated above, it will be inevitable for China to experience changes in energy structure, industrial structure and CO_2 emission intensity.

All of that indicate that CO_2 emission of China in the future will be probably close to the value of CO_2 emission forecasted in the low emission scenario. That is, around 7,162 Mt CO_2.

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