CO_2 Emission Reduction in Shanghai:

Responding to Climate Change Mitigation

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Abstract:

In this paper, energy consumption characteristics and energy intensity in Shanghai were analyzed. Status of carbon source and carbon sink in Shanghai were estimated using the existing known methods. Result shows that the total carbon emission varies significantly depending on the share of renewable energy in energy mix. The carbon emission in Shanghai increased but carbon emission per unit GDP in Shanghai dropped, a result of energy efficiency improvement. Further reduction of carbon emission per unit GDP is dependent on policy innovation, new technology breakthrough or transformation of social economic pattern.The carbon sink in Shanghai is expected to maintain at the current level or achieve some increase in the future, depending on the implementation efforts of policies and technology innovation. The current policies related with carbon emission reduction were summaried. Some suggestions on related policy were proposed.

Key words:

Carbon emission reduction, carbon emission source, sink, China, climate change

1. Introduction

Climate change has been recognized as the most pressing environmental, social and economic problem facing the planet**.** The consequences of climate change are global and long-term. Although cities only cover less than one per cent of the earth's surface, they consume about 75 percent of the world energy and they should be responsible for 80 percent of greenhouse gas emissions[1]. On the other hand, around 50 percent of the world's population live in cities. Hundreds of millions of people in cities across the world will be affected by climate change[2]. So cities bear a large responsibility for global warming and could be a main part of solution to tackle climate change.

Many cities both in developed countries and developing countries started to take actions to address the challenge of climate change. London launched the climate action plan in February 2007[3]. London focused on the CO_2 mitigation instead of just responding to the climate changes that global warming is already bringing and also specified the current and projected emissions, potential actions to reduce CO_2 and Mayor's key priorities for each sector. Chicago[4] and Tokyo[5] carried out their own climate change action plan as well. Both cities identified their own key sectors and outlined detailed actions for their strategy. Among the first for a developing world city, Cape Town issued Energy and Climate Change Strategy[6] which focused on the relationship between energy and climate change, made its contribution to the climate change mitigation.

Table 1. Action plan on CO_2 emission reduction in some cities

City	Issued Time	Name	Target	Main Policies
London	February 2007	the Mayor's climate change action plan	18.0 Mt CO_2 by 2025	Tackle CO_2 emissions from domestic sector, existing commercial and municipal activity, new build and development, energy supply sector, ground based transport and aviation, etc.
Chicago	2007	Chicago Climate Action Plan	6.5 MMt CO_2e[7] by 2050	energy efficient building, clean and renewable energy sources, improved transportation options, reduced waste and industrial pollution and adaptation
Tokyo	June 2007	Tokyo Climate Change Strategy	25% reduction by 2020 from the 2000 level	Advance CO_2 reduction measures by companies powerfully, adopt serious stance on the reduction of CO_2 emissions from households, create rules for the urban development in order to reduce CO_2 emissions, promote the reduction of CO_2 emissions from automobile traffic, create Tokyo's unique system
Tokyo	25th June 2008	Tokyo's Mandatory Cap & Trading Scheme	25% reduction by 2020 from the 2000 level	This scheme covers large CO_2 emitters in Tokyo whose consumption of fuels, heat and electricity reaches 1,500 kiloliters or larger per year.

1 See the website of c40 cities by accessing http://www.c40cities.org/climatechange.jsp. Though many paper show that "cities consume about 75 percent of the world energy and they should be responsible for 80 percent of greenhouse gas emissions", some researchers argue that cities has been blamed too much and they could be a solution to tackle the climate change.

2 See The Cities in Climate Change Initiative, UN HABITAT, URL: http://www.unhabitat.org/content.asp?typeid=19&catid=570&cid=6003.

3 Mayor's climate action plan is called "Action Today to Protect Tomorrow". The report can be found via http://www.london.gov.uk

4 See more details about the "Chicago's Climate Action Plan" by visiting the website: http://www.chicagoclimateaction.org.

5 See the report of "A basic plan for 10-Year Project for a Carbon-Minus Tokyo", June 1, 2007.

6 See more detailed information by accessing the website: http://www. capetown.gov.za

7 Amounts are in million metric tons carbon dioxide equivalent.

Cape Town	August 2005	Air Quality Management Plan (AQMP).	Ensure that clean air is achieved and maintained in the city over the next 10 to 20 years	
		Cape Town's State of Energy Report	specific goals for each sector	Policies are divided into 5 energy visions: transport, commerce & industry, residential, government and energy supply.

Topping the nation in terms of gross domestic product (GDP) and productive forces, Shanghai is one of the most important and developed cities in China and also one of the most vulnerable cities to the impacts of climate change across the world. Currently little research result has been published related with Shanghai effort. So in this paper, status of carbon source and carbon sink in Shanghai were estimated using the existing known methods. The current policies related with carbon emission reduction were summaried.

2. Methodology

The carbon source and sinks are assessed by combining quantitive and qualitive analysis, Quantitive method is to calculate carbon emissions and sinks by use of coefficient approach and sectoral model. Qualitive method is used to compare Shanghai with other similar regions and cities and understand Shanghai's position better. The carbon eission is predicted by combining scenario analysis and field survey. Based on the historic track of social and economic development in Shanghai, the baseline of scenario and different policy scenarios are designed by use of expert consultation and field investigation.

2.1 Calculation of Carbon Source and Carbon Sink

The definition of a carbon source varies depending on the specific application. The following definition for a carbon source applies in this study.

A carbon source refers to nature processes or human activities releasing greenhouse gases, which is expressed as a carbon dioxide equivalent or a carbon equivalent. Due to the limited data sources, this study mainly reviews the carbon sources from the burning of fossil fuels as a carbon equivalent.

There are various methods for the estimation of a carbon source, with most methods calculating the carbon emission based on total energy consumption and fossil fuel coefficient or carbon emission efficient.

Estimation method for CO_2 emission from the burning of fossil fuels as proposed by ORNL (Oak Ridge National Laboratory, 1990), which applies to cases with known energy consumption and energy type.

The equation below can be used to calculate total carbon source:

$$CE = En * k * n$$

Where,

CE = carbon emission volume;

En = energy consumption amount;

k = efficient oxidation fraction;

n = carbon content per ton of standard coal.

The value of parameters varies depending on the energy type.

1) The calculation equation for coal burning:

   Carbon emission= coal consumption × efficient oxidation fraction × carbon content per ton of standard coal (where, efficient oxidation fraction=0.982; carbon content per ton of standard coal=0.73257.)

2) The calculation equation for fuel burning:

   Carbon emission= standard coal equivalent ×efficient oxidation fraction ×carbon content per ton of standard coal × 0.813 (where, 0.813 is ratio of CO_2 released by petroleum and CO_2 released by coal on releasing the same thermal energy.)

3) The calculation equation for gas burning:

   Carbon emission= standard coal equivalent ×efficient oxidation fraction × carbon content per ton of standard coal × 0.561 (where, 0.561 is ratio of CO_2 released by fuel gas and CO_2 released by coal on releasing the same thermal energy.)

According to specific circumstances in Shanghai, the above method was used in this study to estimate the change of total carbon emissions in Shanghai. The standard coal equivalent for fuels and natural gases was determined based on the data published by the *Shanghai Municipal Statistics Bureau.* It should be noted that the estimation of carbon sources is relatively conservative, which only takes into account the carbon emission arising from energy consumption instead of carbon sources caused by change of land use, cement production and ecological system respiration.

2.2 Forecast Method

2.2.1 IPCC SRES Scenario

The IPCC published the special Report on Emissions Scenarios - SRES in 2000, which, based on the analysis on existing greenhouse gas emission scenarios, describes four future global development models. SRES uses four families of scenarios and storylines, consisting of 40 scenarios developed by six modeling groups. Scenario families A1 and A2 emphasize on economic development but differ with respect to the degree of economic and social coverage; B1 and B2 emphasize on sustainable development but also differ in terms of degree of convergence.

2.2.2 Annual growth rate of energy consumption forcast

In accordance with the *Eleventh Five-Year Plan of Shanghai Municipality for Energy Sources Development*， the energy consumption per ten thousand Yuan of GDP in 2010 is expected to decline by 20%, compared with that in 2005. Therefore, the annual growth rate for energy consumption in Shanghai during the "Eleventh Five Year" shall be reduced to 5% from 7.98% in "The Tenth Five Year". Based on statistics, in this study, the energy demand grow rate is selected to be 4.27% (during the Ninth Five Year), 5% (as specified in the Eleventh Five Year Plan), and 7.98% (average growth rate during the Tenth Five Year) respectively. Based on the total energy consumption of 90,500,000 tons of standard coal in 2006, the future total energy demand can be calculated in accordance with the equation below.

$$E = 9050 \times (1 + i)^t \qquad (1)$$

Where,

E =Total energy demand, ten thousand tons of standard coal;

i=Assumed annual growth rate of energy consumption;

t =Number of periods, expressed in the year difference between forecast year and base year.

2.2.3 Energy consumption per capita forcast

To forcast energy consumption per capita, it was assummed that at different economic development stage in different countries and regions, energy consumption per capita is proportional to GDP per capita, that is, certain energy will be consumed for certain GDP per capita when economy reach a certain level.

3. Present Situation and Forecast of energy consumption in Shanghai

3.1 Energy Consumption

3.1.1 Energy consumption characteristics

Energy consumption arising from production activities contributes the most to the total energy consumption of Shanghai, with energy consumption from industrial sector enjoying the largest share. Since 1990, the energy consumption in Shanghai has been growing at a rapid speed. (Figure 1).

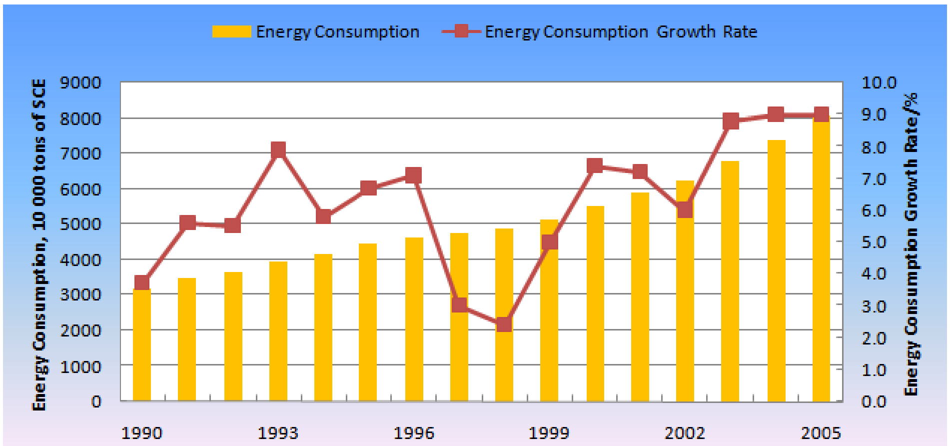

Figure 1 Energy Consumption and Growth Rate in Shanghai (1990-2005)

Source: Shanghai Statistical Yearbook 2006.

It can be concluded that the energy consumption in Shanghai has entered into a stage with the sharpest growth rate since 1990.

It can be found from the change of energy consumption per ten thousand Yuan GDP (see Figure 2), the energy efficiency in Shanghai was also gradually increased. The energy consumption per 10,000 Yuan GDP consistently dropped.

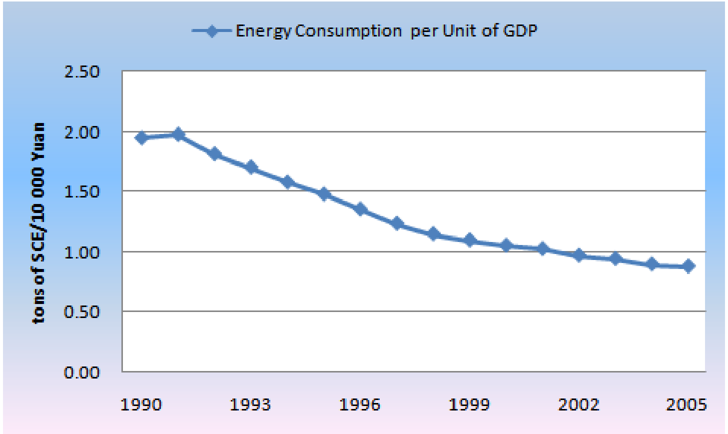

Figure 2 Change of Energy Consumption per Unit of GDP in Shanghai

Source: Calculated by the data from Shanghai Statistical Yearbook 2006
（According to the constant price of year 2005）

The majority of the total energy consumption in Shanghai is derived from coal, and cruel oil, followed by natural gas which belongs to clean energy.

Based on the primary energy consumption data between 1990 and 2005, coal consumption showed a continuous growth, but the increase rate was slowing down year by year. According to the share of different energy sources in energy mix, the energy structure in Shanghai was gradually optimized. Shanghai has made significant progress in energy structure adjustment during the Tenth-Five Year Plan. At the same time, Shanghai has launched projects to utilize renewable energies such as solar energy and wind energy.

Although the energy structure in Shanghai is continuously optimized, coal still holds a dominant position in the energy structure. Therefore, building a rational energy consumption structure will become one major component in Shanghai's carbon emission reduction mechanism.

3.1.2 Energy Consumption Intensity

Energy consumption intensity refers to energy consumption per unit GDP, usually measured as energy consumption per ten thousand Yuan GDP (tons of standard coal per ten thousand Yuan). Low energy consumption intensity indicates a high economic benefit in converting energy into GDP, due to production management improvement and system reform and innovation.

Since 1990s, Shanghai has maintained a rapid economic development; its GDP repeatedly hit new records, and energy consumption per ten thousand Yuan GDP in Shanghai decreased (Figure 4).

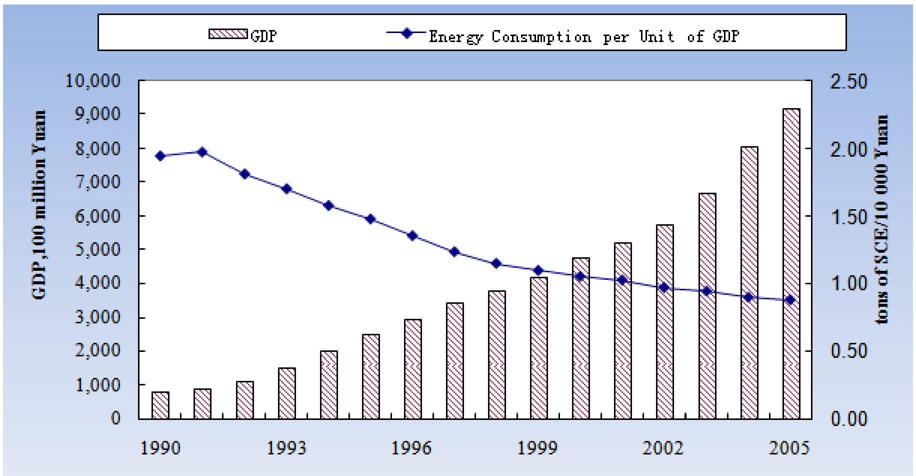

Figure 3 GDP and Energy Consumption per Unit of GDP in Shanghai (1990-2005)

Source: Shanghai Statistical Yearbook 2006

3.1.3 Elasticity ratio of energy consumption.

Elasticity ratio of energy consumption = average annual growth rate of energy consumption/ average annual growth rate of national economy. It is an indicator to show the relationship between the growth rate of energy consumption and the growth rate of the national economy. Elasticity ratio of energy consumption varies depending on to economic development level, industrial structure and energy price, etc.

Since China adopted the policy of reform and opening up, the growth rate of energy consumption in Shanghai was generally lower than its GDP growth rate (Figure 4), except in some particular years. Therefore, the elasticity ratio of energy consumption was lower than 1 for most Years. Since 1990s, this gap was further increased and the elasticity ratio of energy consumption gradually dropped. This indicates that Shanghai maintained sustained and rapid economic development at relatively low energy consumption. The change of elasticity ratio of energy is related to the increase in the share of heavy industries and high energy consumption sectors as well as the rapid growth of energy consumption from residential sector.

In the future, Shanghai government will further enhance energy structure adjustment, so as to control the elasticity ratio of energy consumption at around 0.5 during the Eleventh Five-Year Plan.

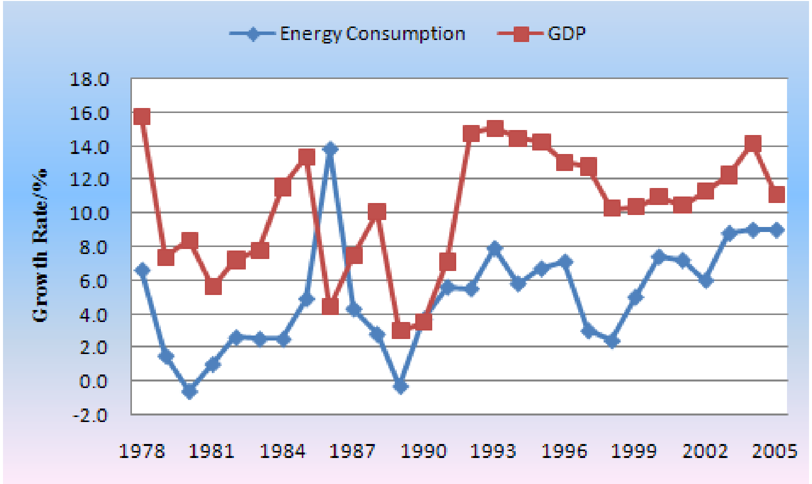

Figure 4 Change of Growth Rate of Energy Consumption and Growth Rate of GDP in Shanghai (1978 - 2005)

Source: Shanghai Statistical Yearbook 2006

3.1.4 Energy Consumption from Residential and Production Sector

Energy consumption in Shanghai is consisted of energy consumption from production sector, and energy consumption from residential sector. Between 1980 and 2000, energy consumption from residential sector accounted merely 10% of the end-user energy consumption, and energy consumptions from the three industries took up more than 90% of the end energy consumption. Therefore, energy consumption from production sector is the major energy consumption in Shanghai.

With continuous improvement of people's living standard, energy consumption from residential sector per capita also showed a trend of increase climbed over the years, and energy structure was developing towards cleaner and high quality energy, with the share of coal and kerosene consumption gradually decreased, and the share of liquefied petroleum gas and coal-bed gas increased rapidly (Table 1). However, the energy consumption structure was remarkably more reasonable in Shanghai. The energy consumption from residential sector in Shanghai is gradually shifting towards a consumption pattern with electricity as dominant energy, petroleum products and coal as supplementary energy.

Table 1 Average Energy Consumption from Residential Sector per Capita in Major Years

Type of Energy	1990	1998	1999	2000	2001	2002	2003	2004	2005	2005 Whole Country
Total (kg SCE)	192	327	292	343	338	355	382	437	**483**	179.4
Coal (kg)	143	161	127	106	106	76.6	59.4	67	53.5	67
Kerosene (kg)	0.65	0.15	0.17	0.05	0.05	0.01	0.01	0.13	0.14	0.2
Liquefied Petroleum Gas (kg)	3.34	14.5	14.9	16	16	14.1	14.4	15.1	18.6	10.2

Coal Gas (m^3)	45.1	85	94.1	121	121	95.1	104	90.4	84.6		11.1
Electricity (kw.h)	112	348	343	403	403	464	618	670	803		216.7

Source: Shanghai Statistical Yearbook 2006 and China Statistical Yearbook 2007.

Energy consumption from production sector consists of energy consumptions from all three industries, and the secondary industry takes the largest share and the share of the tertiary industry saw a continuous growth (Figure 6).

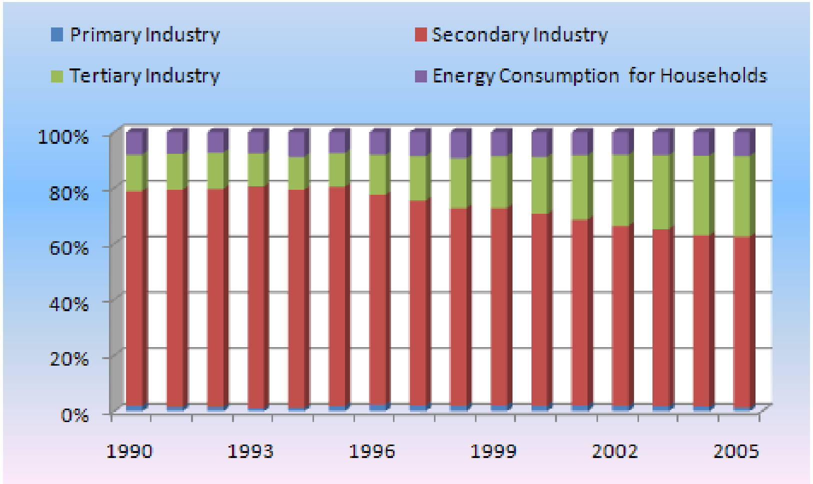

Figure 6 Contribution of Industries to End-use Energy Consumption in Shanghai (1980- 2005)

Source: Shanghai Statistical Yearbook 2006

3.2 Carbon Source and Carbon Sink

3.2.1 Variation of carbon emission in Shanghai (1985-2007)

The carbon emission in Shanghai can be calculated based on statistical data and corresponding method selected. Since the energy consumption data for 2006 in Shanghai are not available, the energy consumption per unit GDP method was used. The total energy consumption (standard coal) can be calculated based on GDP and energy consumption per unit GDP. After that the carbon emission can be calculated, as shown in Figure 6.

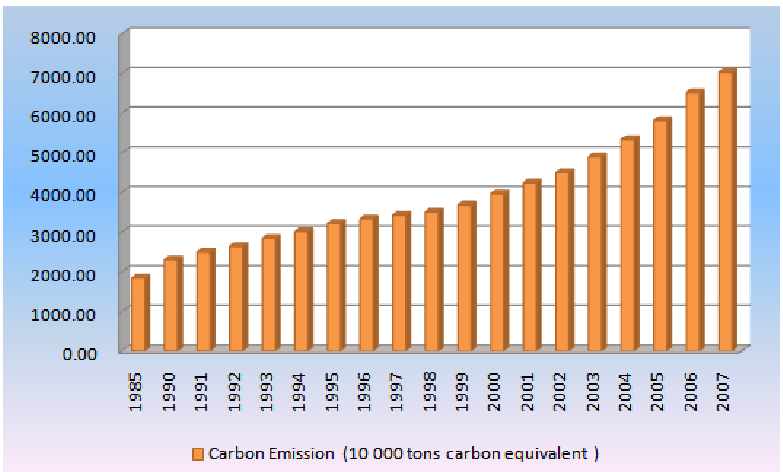

Figure 6 Status of Carbon Emission in Shanghai over the Years (1985-2007)

It can be seen from figure 6 that, the carbon emission in Shanghai increased but carbon emission per unit GDP in Shanghai dropped, a result of energy efficiency improvement (Figure 7). Further reduction of carbon emission per unit GDP is dependent on policy innovation, new technology breakthrough or transformation of social economic pattern.

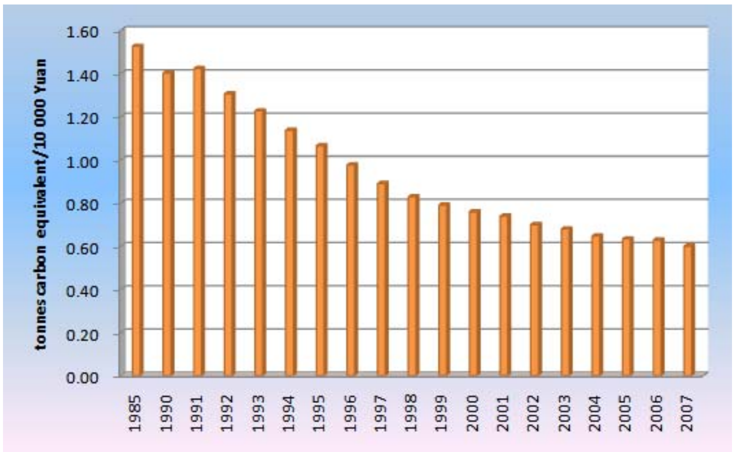

Figure 7 Status of Carbon Emission per Unit GDP in Shanghai (1985-2007)

Source: Calculated by the data from Shanghai Statistical Yearbook 2006 and China Statistical Yearbook2007 etc. （According to the constant price of year 2005）.

3.2.2 Variation of carbon sink in Shanghai (1995-2007)

Based on the carbon sink type in Shanghai, analysis was performed on the parameters for different carbon sink type, and carbon sink parameters are determined for calculation of carbon sink in Shanghai. The carbon sink in Shanghai is mainly consisted of wetland, gardens and green space, soil of farmland and crops, among which crops, as the major carbon sink in Shanghai, contributes significantly to carbon emission reduction in Shanghai.

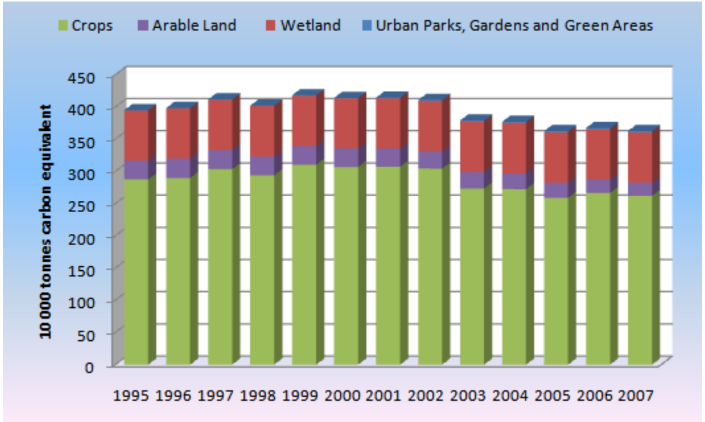

Figure 8 Status of Total Carbon Sink of Shanghai over the Years (1995-2007)

It can be seen from figure 8, the total carbon sink in Shanghai shows a decline trend overall. The most two important carbon sink types in Shanghai are crop sink and wetland sink, especially the crops carbon sink which has affected the trend of the total carbon sink. Although the advancement of farming technique can rise the crop yield to some extent, it cannot catch up the decline rate of arable land. Therefore, more and more attention should be paid to the arable land preserving.

3.3 Forecast of carbon source and carbon sink

The baseline scenario of this research is according to IPCC SRES Scenario. From the government policy, industrial structure and present position, the future emission scenario of Shanghai tends to be A1B and B1 scenario out of the four SRES scenarios. At the same time, as the world energy crisis aggravates, renewable energy, which increasingly gains popularity around the world, develops a rapid rate. The forecast on development trend of renewable energy share, which is determined based on the current status and experiences in renewable energy development home and abroad, as well as the potential and status of renewable energy development in China, is an important part in establishing a comprehensive mechanism in response to carbon emission reduction in Shanghai. In this background, we have done several predictions.

3.3.1 Total energy demands

By comprehensive analysis on annual growth rate of energy consumption method and energy consumption per capita method, the forecast results of total energy demand in Shanghai under different seniors with different growth rate are presented in Table 2.

Table 2 Forecast of Total Energy Demand in Shanghai Based on Comprehensive Analysis of the Two Calculation Methods (10 000 tons of SCE)

Year	Low Speed		Medium Speed		High Speed	
	range	Estimation	range	Estimation	range	Estimation
2015	13200～14860	14000	14860～16520	15600	16520～18100	17500
2020	16300～19700	18000	19700～23100	21400	23100～26600	25500
2030	24700～34700	29700	34700～44700	39700	44700～57200	55000

It can be found that the energy demand situation in Shanghai, which features a high consumption pattern, is not very optimistic. Furthermore, as an international metropolis, more and more people from outside is crowding into Shanghai, causing serious impact on energy security in this city.

3.3.2 Renewable energy

According to *The Eleventh Five-Year Plan of Shanghai Municipality for Energy Sources Development, however*, the renewable energies consumption in Shanghai is expected to reach only 0.5% of projected total energy consumption, far lower than the target as set in *Renewable Energy Development Plan*. Therefore, there is huge potential for the development of renewable energy in Shanghai.

In this study, based on the forecast of total energy demand in Shanghai, comparative analysis was performed on the 12 scenarios plans, where the share of renewable energy was selected to be 0.5% (as specified in The Eleventh Five Year Plan), 8% (the average level in China), 15% (the target in 2020 as set by Development and Reform Commission), and 20% (the target set by EU) respectively. The carbon emission was calculated based on the total conventional energy resource, which was derived by subtracting renewable energies from total energy demands, and the estimation method for CO_2 emission from fossil fuel burning as proposed by ORNL (Oak Ridge National Laboratory). The forecast results are presented in Figure 9.

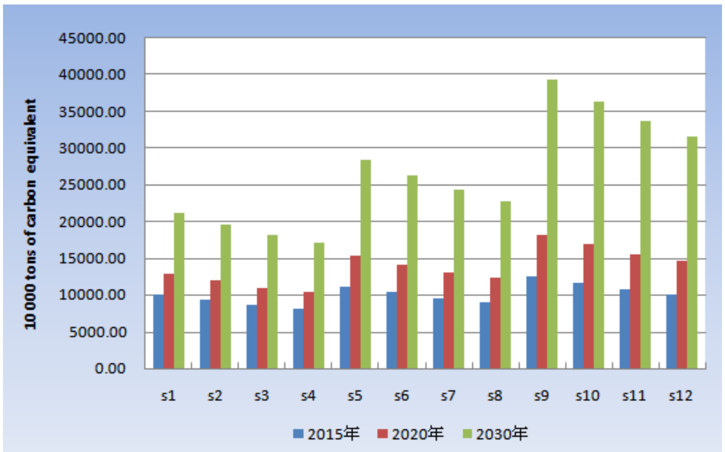

Figure 9 Forecast Results of Carbon Emission under Different Scenarios

It can be concluded that, the total carbon emission varies significantly depending on the share of renewable energy in energy mix. Adoption of different renewable energy development strategy will significantly affect the future carbon emission condition in Shanghai.

3.3.3 Carbon sink

According to the primary estimate results of carbon sink in Shanghai in 1995-2007 the carbon sink, which saw a sharp reduction in 2003, now seems stable. Detailed analysis was performed on each type of carbon sink (including wetland, gardens and green space/forestry land, farmland soil and crops) in Shanghai, so as to project the future development trend of carbon sink in Shanghai.

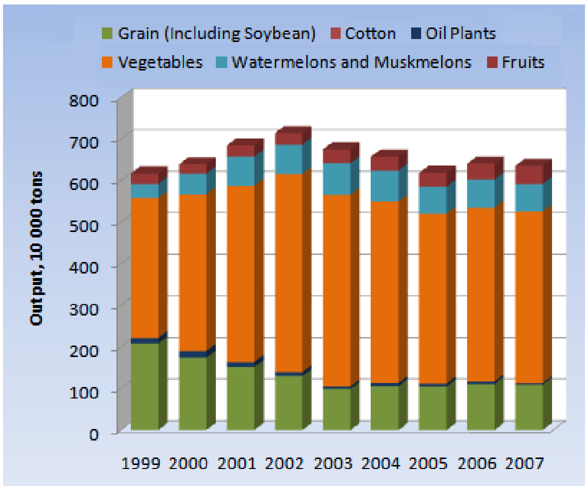

Figure 10 Main Crops Yields in Shanghai (1999-2007)

Source: Shanghai Statistical Yearbook.

With the continuous development of urban economy, Shanghai increasingly pays attention to environmental protection and ecological construction while focusing on socioeconomic development. Therefore, the carbon sink in Shanghai is expected to maintain at the current level or achieve some increase in the future, depending on the implementation efforts of policies and technology innovation.

4. Related policies issued by Chinese government and Shanghai municipality

4.1 China's National Climate Change Programme and White Paper: China's Policies and Actions for Addressing Climate Change

Climate Change has drawn the attention of the world since the signing of "United Nations Framework Convention on Climate Change" (UNFCCC) and "Kyoto Protocol". Then the completion of "IPCC Fourth Assessment Report" (AR4) in 2007 made it become a hotspot. China also pays more and more attention on this issue. Two documents named *China's National Climate Change Programme* and *White Paper: China's Policies and Actions for Addressing Climate Change* were promulgated in June, 2007 and October, 2008 respectively.

"China's National Climate Change Programme" (hereinafter referred to as the CNCCP) put forward guidelines, objectives, basic principles, key areas of actions, as well as policies and measures to address climate change for the period up to 2010 (CNCCP, 2007). “White Paper: China’s Policies and Actions for Addressing Climate Change” (hereinafter referred to as the White Paper) not only reaffirmed the guidelines, objectives and basic principles etc. but also introduced the progress and achievements through the implementation of CNCCP (White Paper, 2008).

In the part IV: Policies and Actions to Decelerate Climate Change, it said “China has adopted proactive policies and taken active actions to slow the process of climate change. It has adopted a number of policies and measures to adjust the economic structure, change the development patterns, save energy and raise the efficiency of energy use, and optimize energy mix and promote afforestation. Marked achievements have been made. ” (White Paper, 2008) This shows that China's emission reduction is mainly carried out over the energy resources. Section 4.2 lists the main policies related to energy at both national level and Shanghai city level (See Table 3 and Table 4).

4.2 Main Policies Related to Energy

The main policies related to energy at both national level and Shanghai city level are listed in Table 3 and Table 4 respectively.

Table 3 Main Policies Related to Energy at National Level

Type	**Policy Name**	**Issurance Organ**	**Time**	**NO.**
General Policies	*The Eleventh Five-Year (2006-2010) Plan for National Economic and Social Development*	The 10th Meeting of the Fourth NPCSC	*Mar 14,2006*	1
	The Plan for Energy Consumption Per Unit of GDP Targets among the Regions during the Eleventh Year	The State Council	*Sep 17,2006*	2
	The Eleventh Five-Year (2006-2010) Plan for Energy Development	NDRC	*April, 2007*	3
	Decision on further Strengthening the Energy Conservation Work	The State Council	*Aug 6,2006*	4
	The Notice of the Implementation Plan for Energy Conservation and Emission Reduction	The State Council	*Jun 3,2007*	5
	Energy Conservation Law (amendment)	The 30th Meeting of the Tenth NPCSC	Adopted on Oct 28, 2007 (came into effect since Apr 1, 2008)	6
Specific Policies	*The Notice of Submitting the Annual Plan for Phasing out Backward Production Capacity in*	NDRC	*Jun 27,2007*	7

	Paper, Alcohol, Monosodium Glutamate, Citric Acid and other Industries			
	The Notice of Strict Implementation of Energy-efficient Building Design Standards on New Residential Building	MOHURD	Apr 15,2005	8
	Guidance to the Development of Energy and Land-efficient Residential Building and Public Buildings	MOHURD	May 31,2005	9
	Energy-saving Management Regulation of Residential Building	MOHURD	*Adopted on Oct 28,2005(came into effect since Jan 1,2006)*	10
	Medium and Long-term Planning Framework for Energy Conservation in Highway and Waterway Transportation	MoT	Sep 23,2008	11
	Ordinance for Energy Conservation in Public Institutions	The State Council	Adopted on July 23, 2008 (came into effect since Oct 1, 2008)	12
	The Notice of Implementation Plan for Thousands of Companies Energy Conservation Action	NDRC，NEO，NBS，GAQSIQ，SASAC	Apr 7,2006	13

Table 4 Main Policies Related to Energy at National Level

Type	**Policy Name**	**Issurance Organ**	**Time**	**NO.**
General Policies	*The Suggestion for further Strengthening the Energy Conservation Work in Shanghai*	*Shanghai Government*	*May 9,2006*	*1*
	Shanghai Eleventh Five-Year Plan for Energy Development	*Shanghai Government*	*Sep 29,2006*	*2*
	Shanghai Eleventh Five-Year Plan for Energy Conservation	*Shanghai Government*	*Jan 26,2007*	*3*
	The Implementation Plan for Energy Conservation and Emission Reduction in Shanghai	*Shanghai Government*	*2007*	*4*
	Shanghai Energy Conservation Regulations(amendment)	*The 10th Meeting of the thirteenth session of SPCSC*	*Adopted on Apr 23, 2009 (came into effect since July 1, 2009.*	*5*
Specific Policies	*Shanghai Building Energy Management* Approach	*SG*	*June 13,2005*	6
	Shanghai Eleventh Five-Year Plan for Transportation	*Shanghai Transportation Bureau*	*Sep 17,2007*	*7*
	Shanghai Energy-efficient Building Design Standards	--	*To be promulgated*	*8*

4.3 General Energy Related Policies

Chinese Government attaches great importance to energy conservation especially since the promulgation of The Eleventh Five-Year (2006-2010) Plan for National Economic and Social Development. The Eleventh Five-Year Plan announced 20% average reduction in the energy consumption per unit of GDP in 2010 (compared with 2005). Then the State Council approved The Plan for Energy Consumption Per Unit of GDP Indicator among the Regions during the Eleventh Five-Year. According to that plan, the energy consumption per unit of GDP in Shanghai shall be reduced by 20% during the eleventh-five year. Subsequently, Shanghai decomposed the indicator among the industries and departments in the Suggestion for Further Strengthening the Energy Conservation Work in Shanghai (2006). In addition Shanghai issued Shanghai Eleventh Five-Year Plan for Energy Development (2006), Shanghai Eleventh Five-Year Plan for Energy Conservation (2007) and the Implementation Plan for Energy Conservation and Emission Reduction in Shanghai (2007) to further determine the targets and measures for energy conservation.

Energy Conservation Law was amended to meet the current and further need for energy conservation and the amended *Energy Conservation Law* was adopted by the 30th Meeting of the Tenth National People's Congress Standing Committee on October 28, 2007 and came into effect since April 1, 2008. Compared with the old version, a large number of amendments were made in the new *Energy Conservation Law*（FU，2008）:

1） Improve the basic system of energy conservation. It is the first time that “Resources Conservation” has been confirmed as one of the basic national policies in China at law level. It provides a series of energy conservation management system, including the implementation of energy conservation target responsibility system.

2） Expand the scope of legal regulation. It not only improves the provisions relating to industrial energy conservation, but also adds some new sections, such as building energy efficiency, transport energy conservation, energy-efficient public institutions and key energy consumption companies.

3） Confirm the fundamental role of energy conservation standards. Provide for the development of mandatory energy efficiency standards of energy products and equipment as well as the standard limits for high energy consumption products. Encourage the enterprises and local government to develop higher energy efficiency standards.

4） Increase the policy incentive intensity. Add the new section of “Incentive Measure”. It provides that encourage and guide reasonable use of energy through taxation, prices and other economic policy.

5） Enhance the pertinence and operability of the law. Further defined the responsibilities of the relevant government departments in the energy management and supervision. Carried out a number of detailed provisions according to the problems existed in the implementation of the old laws. In addition, more provisions of liability were added and the penalties for violations were increased.

Shanghai has also amended *Shanghai Energy Conservation Regulations*. And the amended version was adopted by the 10th Meeting of the thirteenth session of Shanghai Municipal People's Congress Standing Committee (SPCSC) on April 23, 2009 and came into effect since July 1, 2009. The amended parts are similar to the national ones.

4.4 Specific Energy Related Policies in Main Sectors

In addition to the above general laws and regulations, administrative regulations and normative documents, China promulgated a series of more specific policies covering industry, construction, transportation, public institution and key energy consumption companies. For example: To carry out the requirements on “Make more efforts to phase out backward production capacity in paper, alcohol, monosodium glutamate, citric acid and other industries” in *The Notice of the Implementation Plan for Energy Conservation and Emission Reduction by State Council (2006)*, National Development and Reform Committee (NDRC) promulgated *The Notice of Submitting the Annual Plan for Phasing out Backward Production Capacity in Paper, Alcohol, Monosodium Glutamate, Citric Acid and other Industries* in 2007; to implement energy conservation in the construction, the Ministry of Housing and Urban-Rural Development (MOHURD) promulgated *The Notice of Strict Implementation of Energy-efficient Building Design Standards on New Residential Building (2005), Guidance to the Development of Energy and Land-efficient Residential Building and Public Buildings(2005) and Energy-saving Management Regulation of Residential Building (2006)*; to implement transportation energy conservation, the Ministry of Transportation promulgated *Medium and Long-term Planning Framework for Energy Conservation in Highway and Waterway Transportation (2008); to implement energy conservation* *in public institutions, the State Council promulgated Ordinance for Energy Conservation in Public Institutions (2008); to implement energy conservation in key energy consumption companies, the NDRC,* the National Energy Office (NEO), National Bureau of Statistics (NBS), General Administration of Quality Supervision, Inspection and Quarantine (GAQSIQ) and State-owned Assets Supervision and Administration Commission of the State Council (SASAC) promulgated *The Notice of Implementation Plan for Thousands of Companies Energy Conservation Action* (2006).

Shanghai municipal government (SHMG) also promulgated a series of specific policies in accordance with the relevant national documents, such as *Shanghai Building Energy Management Approach (2005), Shanghai Eleventh Five-Year Plan for Transportation* (2007) etc. Shanghai's energy policies also covered 5 key sectors from industries to key energy consumption companies. For example, Shanghai shall strictly implement national regulation on "list of phase out out-of-date technique and product" to promote the phase out of the high energy consuming, heavy polluted technique, equipment and production line in the industries sector（*Suggestion for further Strengthening the Energy Conservation Work in Shanghai*，2006）; In the respects of building energy conservation, eco-building was promoted. The newly built constructiton shall strictly follow the requirment of 50% energy saving national standard and make effort to save 65% to meet the higher requirment. And during "the eleventh five year" period, 30 million m^2 old building should be rebuilt or refurnished to save energy（*The Implementation Plan for Energy Conservation and Emission Reduction in Shanghai*，2007）；as for communication and transportation, the priority strategy should be adopted completely to save energy from the transportation equipment and facilities（Eleventh five year plan on shanghai communication, 2005）；and those big energy-consuming facilities and institution should pay more attention on engery saving. Those institutions or organizations will be managed according the caterory. And the relative responsiblities will be strenghthened. ect.（*The Implementation Plan for Energy Conservation and Emission Reduction in Shanghai, 2007*）

5 Analysis of Shanghai and other international cities

Based on the comparison between international data as published by UNDP in 2007 and the results of this article, the carbon emission per capita in 2004 in Shanghai was about 2.9 times of average level in China(based on resident population), 2.4 times of world average level, approximately 50% that of USA and Canada and 68% that of Australia. The carbon emission in other developed countries such as Japan, Russia and many other EU countries, however, is lower than that of Shanghai. Therefore, there is much potential for Shanghai in reducing carbon emission per capita (as is shown in figure 11).

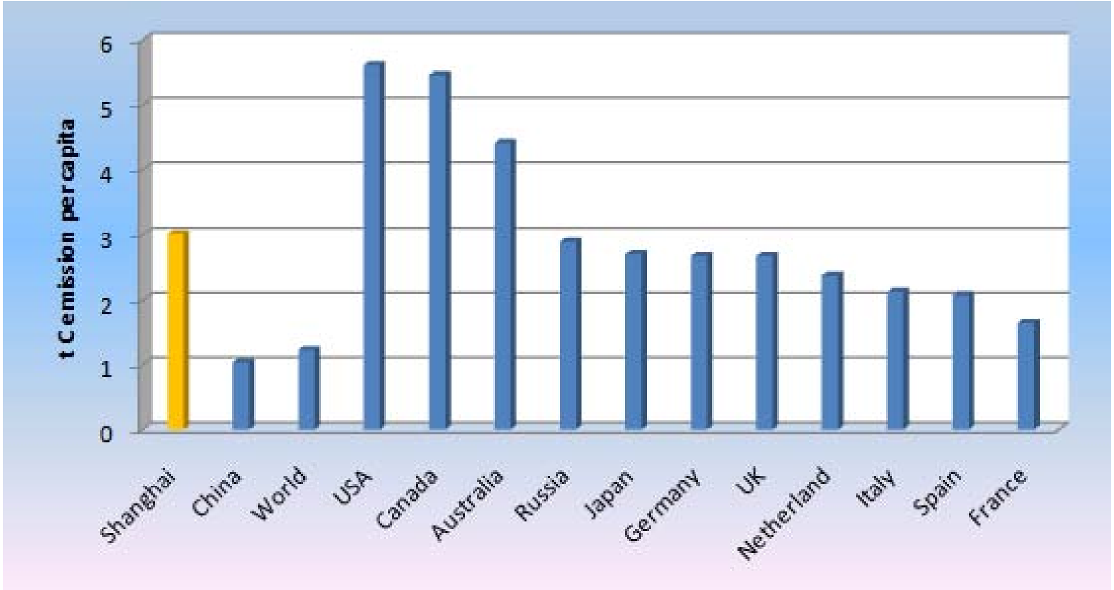

Figure 11 Comparison of Carbon Emission Per Capita in Shanghai and other International Countries (2004)
Source: UNDP, Human Development Report 2007-2008.

Based on carbon emission status over time, it can be found that Shanghai witnessed the highest growth rate of carbon emission per capita during 1990-2004, which not only higher than national and international average, but also higher than that the average in developed countries (See Figure 11). In summary, the carbon emission per capita in Shanghai in 2004 ranked top in the world, although the carbon emission per capita in Shanghai in 1990 was still lower than that in developed countries. This indicated that the carbon emission control in Shanghai was not as effective as that in developed countries.

6. Suggestion and Comments

To make effort on climate change mitigation, the following five aspects should be considered in establishing the carbon emission reduction measures. First, carbon emission should be controlled from the source by optimizing industrial and energy structure. Second, process supervision and management should be enhanced, including carbon accounting management and energy saving and emission reduction management. Third, emphasis should be given to end of pipe control, to protect ecological carbon sink, promote greening construction and wetland and farmland protection based on the characteristics of different regions. Fourth, the public awareness should be enhanced to effectively deal with the climate change.

6.1 Control of emission from the source

1) Accelerate the adjustment of industrial structure and energy consumption structure

Efforts should be made to further optimize and adjust industrial structure, and vigorously develop modern service industry. Meanwhile, the objectives for the development and adjustment of the industrial structure in Shanghai should be identified, and specific measures for corresponding industry, system, and district or county should be established. The energy saving target should be specified and broke down. The accounting and evaluation work should be also enhanced. Industry guidance and industry policy should be established to accelerate circular economy, and continuously strengthen control, upgrading and elimination of high energy consumption industry, enterprises and products.

2) Identify energy saving targets, and emphasize energy saving on supply side

Emphasis should be given to realize energy saving and emission reduction targets in key energy consuming industries, enterprises, equipment and products. Energy saving technology should be oriented towards the top 800 energy consuming enterprises with annual energy consumption exceeding 5000 tons of standard coal, including commercial, tourism, education and hospitals, which energy consumption made up 66% of Shanghai's total. The industrial association's function in coordination and supervision should be fully exerted, to carry out audit the energy saving and carbon emission status of the enterprises one by one. Product admission system should be established and enhanced to prohibit and control the manufacturing and consumption of high energy consuming products, and prevent industries and projects with high energy consumption but low output from being constructed in Shanghai.

Energy saving on the supply side includes energy saving from systems such as primary energy supply, power supply, heating system, etc. Energy saving on power supply side should be concluded by making establishing generation capacity plan for new and old generation sets, so as to reduce the coal consumption from comprehensive power generation. In order to achieve the above objective, efforts should be exerted to develop an operating mechanism which allows high efficiency generator sets to generate more electricity, and low efficiency generator sets to generate less electrify.

3) Strengthen energy saving in building and transport sectors

Presently, energy consumption from building sector (including energy consumption by air conditioning system) is the bottle neck in the reduction of energy consumption due to its consistent increase over the years. Laws, regulations, standards and implementation rules with more stringent energy saving requirements should be issued. Corresponding planning and incentive mechanism should be established and implemented step by step. Energy efficiency in public buildings should be improved. The planning department should perform examination and approval of various buildings strictly in accordance with relevant laws and regulations, including the buildings designed with high energy consumption glass wall and oversized open space, especially the buildings for government sector and public buildings. Support should be given to enterprises in raising counterpart fund for project concerning energy efficiency renovation of existing residential buildings. For newly constructed buildings, the supervision and management over the overall processes including project application, design, construction, acceptance and use, etc. should be enhanced, so as to prevent incompliance with energy saving standards.

Mature, high performance energy saving thermal isolation system should be promoted, new energy saving material and system should be developed, and outdoor testing base for energy saving system should be established. Qualification system for enterprises or organizations performing building design, material supply, construction, supervision, etc. should be strictly implemented, and practicable construction energy saving testing and evaluation system should be applied.

Presently, 85% of gasoline is consumed by motor vehicles, and the potential for energy saving from transport sector is at about 10%-30%. Policies focusing on public transport should be made, to actively promote intelligent transport control system, and reduce deadhead rate of public transport vehicles. Government public vehicle-using system should be reformed to save energy and use clean energies. Meanwhile, alternative energy sources such as dimethyl ether, hybrid power, hydrogen energy should be developed to as new approaches to save energy from transport sector.

4) Accelerate the application of clean coal technology

The increasingly mature of clean coal technology makes it possible for Shanghai to use more coals. Shanghai will basically eliminate scattered coal use, and utilize coal in centralized power generation and chemical industry, so as to realize high efficiency and clean use of coal. Environmental policy maybe implemented in conjunction with price policy to maximize economic and social benefit. Strategies including centralized usage, centralized pollution control and high efficiency usage should be implemented to reduce pollutant emission while satisfying coal demand, and gradually mitigate the conflicts between coal consumption and environmental protection.

5) Actively guarantee gas supply and effectively use gases

The use of natural gases should be under the centralized control in accordance with natural gases supply and intended purpose. The natural gas generator sets are not suitable for base load power generation, due to the insufficient supply and high price of natural gas. Based on the principle of economical and rational use of natural gas, it is not suitable for base load power generation in the future either, even though the natural gas supply may increase gradually. Therefore, natural gas is only suitable for use in high peak load power generation. Two pricing systems should be used for gas-fired power plant implementing peak load regulating operation and peak operation.

6) Actively promote the development and utilization of renewable energy

The renewable energy in Shanghai is featured by limited supply and sustained high price, with the price for wind energy and solar energy respectively 2 times and 10 times the current on-grid power price. Therefore, policies should be established to accelerate renewable energy projects.

6.2 Strength process control, enhance energy saving and emission reduction as well as carbon source and carbon sink accounting

Process control and management must be strengthened and energy saving accounting system must be improved in order to proactively deal with climate challenge, and fulfill the energy saving and emission reduction targets of Shanghai by the end of the Eleventh Five Year Plan.

1) Establish and improve index system

Statistical Department at each levels should attach importance to energy saving and emission reduction as well as carbon source and carbon sink evaluation, by further establishing and improving energy saving and emission reduction as well as carbon source and carbon sink index system , monitoring system and evaluation system. In addition to incorporating the annual plan index system for energy saving and emission reduction and corresponding jobs of specific projects into the index system, evaluation on carbon source and carbon sink index should be gradually implemented to control total amount index and project task objective.

2) Data standardization and normalization

Statistical Department should issue statistical standard and specification for carbon source and carbon sink, conduct accounting work of related data in accordance with the evaluation index of carbon source and carbon sink, and provide various statistics material and data required for phased summarization, analyses and evaluation.

3) Implement announcement system

Statistical Department should implement announcement system to publish carbon source and carbon sink index fulfillment status. Pollutant emission data online reporting system and emission reduction measure and allocation system should be established to realize online automatic monitoring and control over national major pollutant sources, construct pollutant emission three stage tridimensional monitoring system, and publish annual pollutant emission data of major enterprise monitored to the public.

6.3 Develop ecological carbon sink

Policy should be made to develop ecological carbon sink.

1) Wetland protection

Measure should be taken to enhance the protection of wetlands according to functional categories, including important wetlands such as Jiuduansha, Hengsha shallow shoal, Chongming east tidal flat, Nanhuizui wetland, etc. Furthermore, efforts should be made to recover the hydrological condition of the wetland, create and recover plant carbon reservoirs and soil carbon reservoirs by growing aquatic plants. Management strategy should also be made to increase the carbon sequestration capacity of wetland. In addition to the vast wetland in Chongming County, considerable area of wetlands can be found in other districts and counties in Shanghai. The effect of wetland on carbon emission reduction should be exerted in such districts.

2) Farmland protection

The most stringent farmland protection system should be implemented and economic and intensive use of land should be advanced to protect soil carbon sink. Protection of farmland is not only essential for agricultural production, but also helpful to environmental protection.

6.4 Promote public awareness

Featured by highly developed economy, high standards of living, and high energy consumption per capita, energy saving and emission reduction are not only the responsibilities of enterprises, but also closely correlated to living of people. Incentive mechanism with public and enterprises participation should be established to further the participation and supervision of public. Environmentally, it is to promote household and community activities and proactively advocate economic consumption pattern and living habits. Education should be carried out to raise the public’s awareness of energy saving and emission reduction by encouraging people to take public transportation to work and travel, etc. In addition, relevant channel and system should be established for the announcement of climate change information so as to broaden public participation and supervision channel, and fully exert the supervision and opinion affluences function of news media. The transparency of decision-making process concerning climate change should be improved to realize scientific and democratic management of climate change.

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