

Research and Practice of Low Carbon Society in China

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Abstract: Due to high carbon emission in production and low carbon emission in consumption, China is facing a severe test in economic development and carbon emission control. If the model of western developed countries is followed, it is likely that China will take the old road of high consumption and high emission while enhancing economic growth and living standard substantially. Therefore, a complete and systematic low carbon development pattern is very important to China. The core tenet of low carbon society is to coordinate the conflict between development and carbon emission reduction target. However, it does not emphasize only on the change of economic model but tries to create a completely new form of human society development through overall transformation of social mechanism, institutional design, regional planning and life style. After summarizing the study on and practice of low carbon society in China and comparing international low carbon society concept and method, it is found that China has deficiencies in comprehensive approach to low carbon society, leading role of low carbon cities in building a low carbon society and public awareness on and participation in low carbon, which are the key points of study and practice in the future.

1 Concept of low carbon society for China

Low carbon society (LCS) was initially proposed in the Japan-UK Joint Research Project on “Sustainable Low Carbon Society”^[1] and its core content are: in accordance with the principle of sustainable development, ensure that the development needs of all groups within society are met, make equitable efforts to stabilize greenhouse gases concentration and avoid catastrophic climate change, use low carbon energy sources and technologies to increase energy utilization efficiency and adopt the patterns of consumption and behavior that are consistent with low levels of GHG emissions.

The International Research Network for Low Carbon Societies (LCS-RNet) was established in 2008 G8 summit, which inherited the main contents of Japan’s concept of low carbon society^[2] and extended them to the other developed and developing countries.

There are four instructive points for China in low carbon society frame.① Emphasize the overall change of social form including social mechanism, institutional design, regional planning and life style to create a scenario of sustainable development society with low emission of greenhouse gasses emission^[3,4].

Matsuoka^[5] provided two realization scenarios in the Low Carbon Society project, Scenario A (*Doraemon*): high tech, high enjoyment, high convenience,

urbanized assembled life and production, 2% annual GDP growth; Scenario B (*Satsuki and Mei*): people live in harmony with nature; scattered communities and low speed development. ② Emphasize the setting of the target of greenhouse gases emission^[1,6] and use this target to drive the whole society towards to low carbon in all aspects. Japan's low carbon society target is to reduce CO₂ emission by 60~80% in 2050 compared with present and CO₂ emission reaches the peak value in the next 10~20 years. ③ Emphasize the role of cities in low carbon society. A city is a complex and a dense area for human activities and energy consumption and its design and development direction have a strong demonstration and leading effects^[7]. ④ Emphasize the important significance of public ideology, life style and consumption pattern for building a low carbon society^[1,4,8].

In China the counterpart concept of low carbon society is low carbon economy or low carbon development. It emphasizes development on the condition that greenhouse gases emission is minimized and the adverse effect of climate change is mitigated while economic growth is maintained, and thus it is an economic development form of low energy consumption, low pollution and low emission^[9-11]. Nevertheless, China's concept of low carbon economy is more narrow compared to low carbon society and it neither emphasizes the change of overall society mechanism and institutional design nor focuses on the social individuals' patterns of consumption and behavior. But as low carbon development is accepted by all fields, the concept of low carbon society finds growing acceptance in China.

Many concepts and methods of low carbon society are included in the design and planning of Pudong in Shanghai, China^[12]. China still lacks integration and recognition of the whole society's comprehensive scheme. Strachan *et al* considered, through model analysis, that it is very important to realizing a low carbon society those countries especially developing countries take whole social integral measures^[13]. Barker *et al*^[14] concluded, through model simulation, that by taking the comprehensive measures including carbon price policy, China's GDP losses will drop from 10.1% to 3.4% and CO₂ emission will decrease by 1.83 billion tons in 2050 compared with only implementing carbon price policies.

In 2009, Chinese government definitely promised to reduce CO₂ emission per unit GDP by 40~45% in 2020 compared with 2005 in Copenhagen Conference. This commitment sets the clear direction and goal for China to develop a low carbon society in the near term. China now urgently needs to issue the comprehensive low carbon society schemes for achieving this goal.

2 National and regional CO₂ emission in China

In 1990~2005 China's economy developed at a high speed and China also made significant achievements in industrial restructuring, energy saving and consumption reduction. Figure 1 shows the relation between China's economic development and carbon emission in this period. Obviously, in this period China's economy grew by 325.86% and annual average GDP growth was 8.6% but CO₂ emission rose by

14.51% and emission intensity fell by 43.29%, average annual drop being 2.89% compared with 1990. As a whole, in 1990~2005 China developed gradually towards low carbon and weak decoupling of economic growth and carbon emission was realized^[15]($\Delta \text{CO}_2/\Delta \text{GDP}=0.4<0.8$).

China still falls behind developed countries in development level and energy efficiency yet. According to Table 1, China's human development index (HDI) is only close to the global average level and still has a big gap to developed countries (OECD countries) and thus developing economy and improving citizens' living standard are still China's primary target. China's CO₂ emission per unit primary energy source, CO₂ emission per GDP and CO₂ emission per kWh from electricity and heat generation are all higher than world average level and developed countries, indicating that China is still in the high carbon production period and energy utilization efficiency in production process is low. China's industry and building CO₂ emission per capita is much higher than the world level, close to the level of developed countries, indicating that although China has a large population base, the high energy consumption and high emission industrial production makes this indicator stay high. Per capita CO₂ emission and per capita CO₂ emission in transport are much lower than the level of developed countries and these two indicators are closely related to living standard. Hence, these two indicators will grow with increase of economic development and living standard. The high carbon emission at production end and low carbon emission at consumption end indicate that China faces an urgent low carbon society transformation. If the old development road of western developed countries is followed, it is very likely that China will develop into a high consumption and high emission economic model.

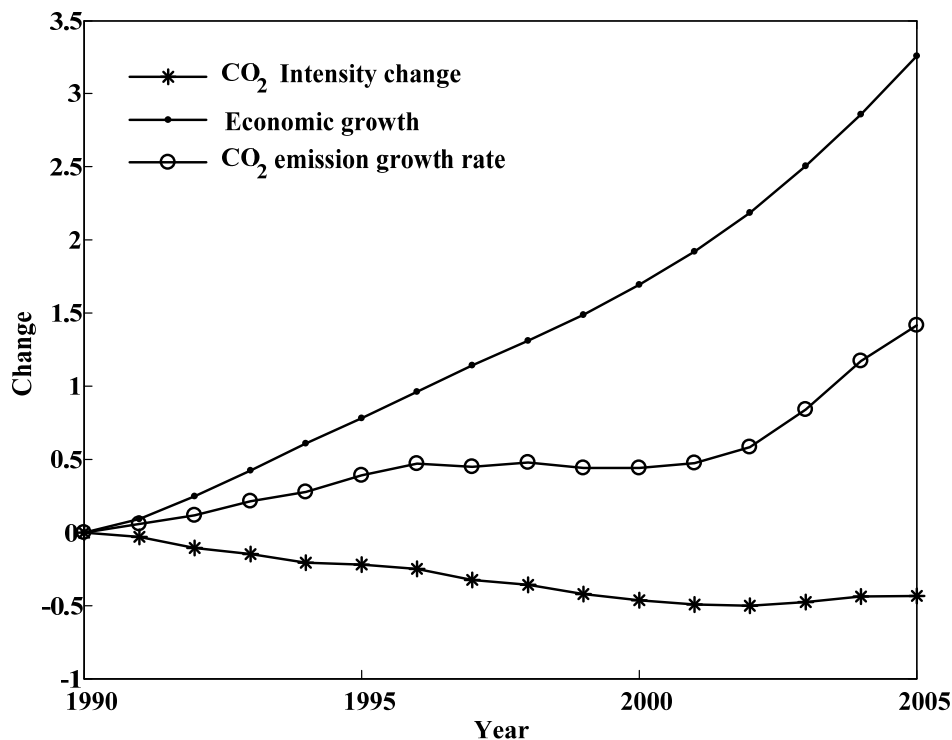


Fig. 1 China's economic development and CO₂ emission in 1990~2005(compared to 1990 Year)

Table 1 Comparison of key indicators between China and world in 2007

Country/region	Human development index (HDI)	CO ₂ emission per unit primary energy source (t/TJ)	CO ₂ emission per GDP (kg/\$2000)	Per capita CO ₂ emission (t/person)	Per capita industry and building CO ₂ emission (kg/person)	Per capita CO ₂ emission in transport (kg/person)	CO ₂ emission per kWh from electricity and heat generation (g/kWh)
China	0.772	73.6	0.6	4.58	1427	310	758
Average of OECD countries	0.932	56.5	0.4	10.97	1599	2990	448
Global average	0.753	57.5	0.47	4.38	865	1004	507

Note: data from [16] and [17]

Since regional economic development, energy structure and living standard differ greatly in China, per capita CO₂ emission in provinces is very different. The emission is the highest in Shanxi province, about 10.4 times of that in Hainan province, which is the lowest.

According to the “Statistical Review of World Energy 2010” issued by BP, China’s consumption of primary energy sources in 2009 was 3.11 billion tons of standard coal and if plus energy consumption in Hong Kong, China has overtaken the United States to become the biggest energy consumer in the world. In 2009 when global emission of greenhouse gases dropped, CO₂ emission from fossil fuels in China rose by 9% compared with 2008, reaching 7.5 billion tons, and China became the first country whose CO₂ emission exceeded 7 billion tons^[18]. Any way, under more and more imminent carbon emission reduction pressure, developing a low carbon society is not a choice but how to carry out.

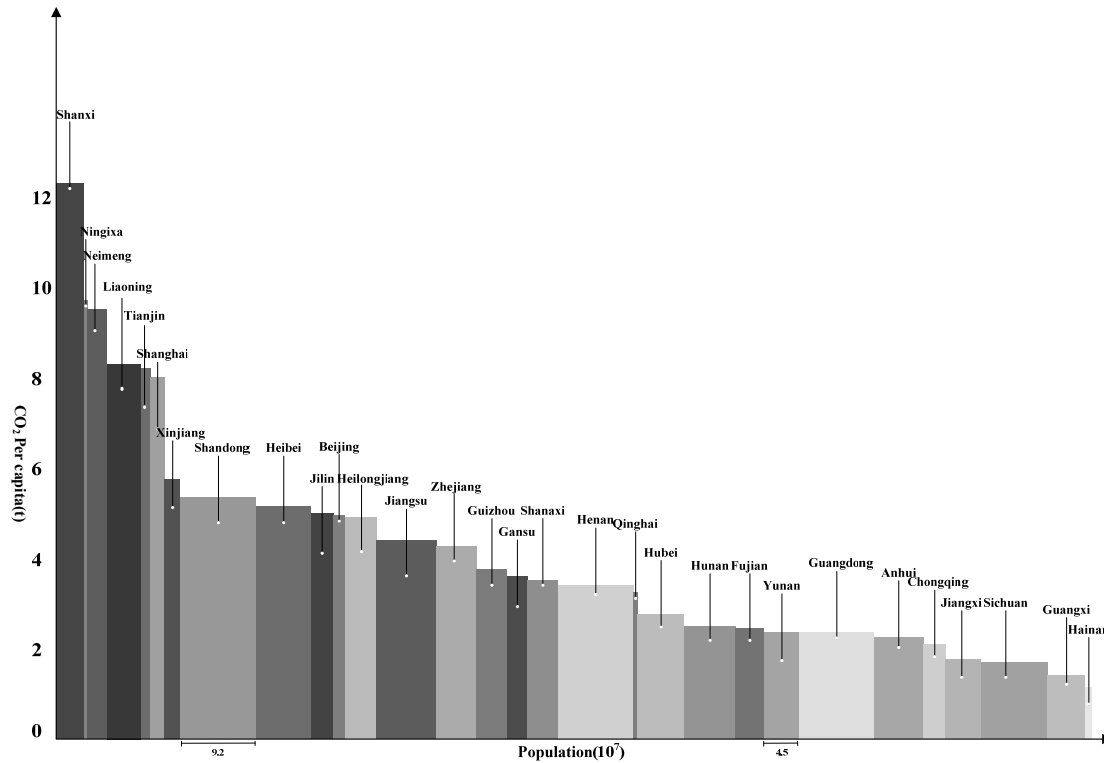


Fig. 2 Provincial per capita CO₂ emission and total emission in China in 2005 (Excluding Hong Kong, Macao, Taiwan and Tibet)

3 Research progress on low carbon society in China

Domestic scholars have made active efforts and brilliant achievements in the study on low carbon society. The “China human development report 2009/10-China and a Sustainable Future: Towards a Low Carbon Economy & Society” jointly written by UNDP and Renmin University of China in 2010 comprehensively expounds China’s understanding of low carbon society and low carbon development, China’s present carbon emission, China’s future low carbon emission scenario and low carbon transformation, low carbon technology road map and low carbon society development policy suggestions etc^[19].

In addition, “2050 China energy and CO₂ emission report” and “China’s low carbon development pathways by 2050-scenario analysis of energy demand and carbon emissions” published by the Energy Research Institute under the National Development and Reform Commission (ERI NDRC) studied in depth the present carbon emission level and technology in China, used IPAC model to simulate various scenarios of medium and long term carbon emission in China and finally put forward policy suggestions^[20,21]. Chinese Academy of Social Sciences summarized the latest achievements in China’s combating climate change and published green book of addressing climate change, the “Annual report on climate change actions (2009)--The Road to Copenhagen” which is systematic compilation and induction of the study on low carbon society in China^[22].

Domestic scholars are conducting more and more active, thorough and comprehensive studies on low carbon society. Figure 3 summarizes, through literature searching analysis, domestic scholars' academic situation of developing a low carbon society in China. Although literature search can not count the literatures in the low carbon study field without omission, its trend indeed can represent the enthusiasm and study of Chinese scholars in this field. Since 2005, various academic articles on low carbon society keep increasing in China (although only 7 months were counted in 2010), indicating the attention and thinking of China's academic field for low carbon society.

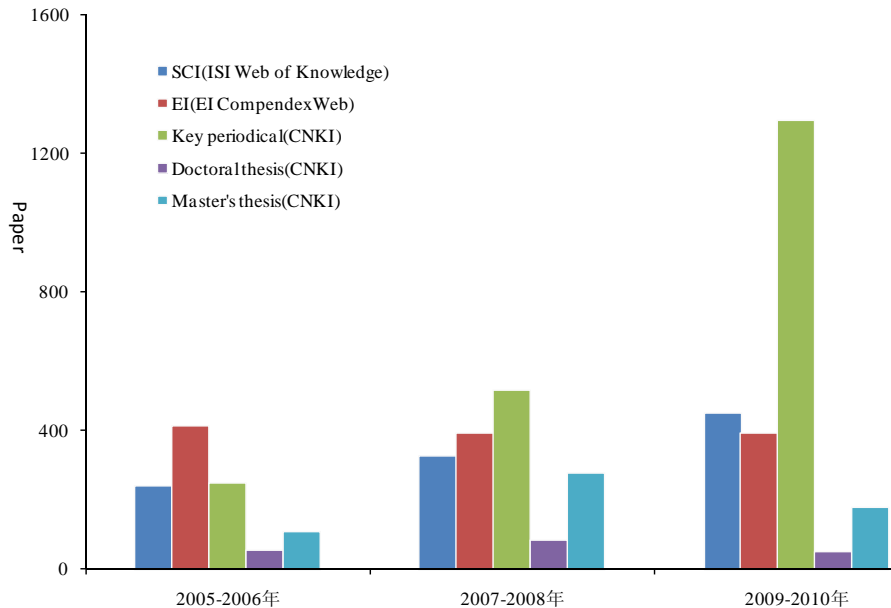


Fig. 3 Study literatures for low carbon society in 2005~2010

Note: SCI search includes SCI, SSCI, A&HCI and ISTP database; English search key words: "Greenhouse gas" OR "Low carbon development" OR "Low carbon economy" OR "Low carbon society" AND CU=China; Chinese search key words: "温室气体" OR "低碳发展" OR "碳排放" OR "低碳经济" OR "低碳社会"; the cause for fewer master and doctor theses is that when this paper is written, the master and doctor theses in 2010 have not been entered in the database system.

For the focus and hot issues in the development of low carbon society in China, e.g. total CO₂ emission cap, carbon tax policy etc., Chinese research institutions like Tsinghua University, the ERI and Chinese Academy for Environmental Planning under the Ministry of Environmental Protection have raised their respective opinions. Since Chinese Government has made a commitment to the reduction target of carbon emission intensity, many domestic scholars considered that from China's pollutants control experience, total emission control target is easier to realize and evaluate than intensity and add to promoting the growth and development of domestic voluntary carbon emission reduction. Therefore, domestic scholars have proposed different total CO₂ emission control targets in 2020, basically between 8~9 billion tons. For carbon tax, Chinese scholars have also carried out in-depth study and intense discussion. The common understanding that carbon tax is the key step and the economical measures with the highest market efficiency for realizing a low carbon society has been reached.

All scholars think that choosing an opportunity to issue the carbon tax is an important action for China to address climate change^[19,21,23]. For carbon tax collection level, experts suggest that should be controlled at 20 RMB/tC in the near term and gradually increased afterwards, and it can reach 30~150 RMB/tC in 2020. The carbon tax frame proposed by Wang Jinnan, which is of “*a low tax rate, wide tax base, low impact, neutralized*”, is the most likely be implemented carbon tax scheme in China^[23].

To push forward the development of carbon trade market in China, Beijing Environment Exchange is studying on the “Panda Standard” and Tianjin Climate Exchange is focused on the voluntary carbon reduction standard, all in an attempt to set a voluntary emission reduction standard for Chinese market. It will determine emission reduction test standard and principle and meet the demand of domestic enterprises and individuals to take actions for climate problems. At the same time, Beijing Environment Exchange is studying and issuing China Low Carbon Index. By using the corrected market value weighting method, integrated weight is allocated to 9 low carbon sectors and weight is allocated to individual shares in the index based on their corresponding sectors and circulating market values. Low carbon index can reflect China’s low carbon industry development and securities degree.

4 Practice progress of low carbon society in China

Chinese Government has made active efforts and unremitting practice in developing a low carbon society. It promulgated the “Renewable Energy Law of People's Republic of China” in 2005 and issued the “China national Climate Change Programme” in 2007 and the white paper of “China’s Policies and Actions for Addressing Climate Change” in 2008, which has drawn a blueprint for China’s low carbon society and new energy resources. In the annual report of “China’s Policies and Actions for Addressing Climate Change-2009” published in 2009, Chinese government summarized in detail various policies, measures, efforts and achievements in reducing energy consumption and CO₂ emission. In 2009, Chinese government made a solemn commitment that it will reduce unit GDP CO₂ emission by 40~45% in 2020 compared with 2005, which defined the goal for the development of a low carbon society in China.

The energy saving goal in the Eleventh Five Year Plan period (2006-2010) is to reduce unit GDP energy consumption by 20% compared with end of the Tenth Five Year plan period (2001-2005). China has taken actions such as ten major energy-saving projects, Top-1000 Energy-Consuming Enterprise Program, phasing out backward production capacities and encouraging new energy automobiles, which not only increasing energy utilization efficiency but also reducing CO₂ emission. If the 20% energy saving goal is realized, 1.5 billion tons of CO₂ will be reduced compared with the baseline scenario and this vigorously pushed forward the development of low carbon society in China.

Local governments and cities in China have higher passion and enthusiasm for low carbon society than the central government. Since 2005, many cities and

provinces have clearly proposed low carbon development and more local governments have included “low carbon economy” and “low carbon development” in their annual government report. Figure 4 shows the experimental spots of low carbon provinces and low carbon cities determined by the National Development and Reform Commission as well as the low carbon city goals determined by local cities itself and cities with low carbon city plans initiated or completed.

Shanghai and Baoding became the first cities joining a new WWF initiative to explore ways for low carbon development in China’s urban areas. The Low Carbon City Initiative will initially focus on energy efficiency in buildings, renewable energy and manufacturing of efficiency products. Baoding is expected to be a global “Electric Valley” for sustainable energy production.

Shanghai is considered to be the most vulnerable port city in China if damaging climate change is out of control. The first-stage priority in Shanghai mitigation measures has been on increasing the energy efficiency of buildings and transportation through its support of demonstration projects, such as the furniture giant IKEA. The SHANGHAI EXPO 2010 highlights low-carbon exhibits. Wuxi aims to become ecologically sound and low carbon city. Wuxi is the first city that completed the strategic plan for development of low-carbon city in China.

Rizhao city, Wenjiang district in Chengdu city, Tongji University and URBN hotel have joined the UNEP Climate Neutral Network. They made commitment on the greenhouse gas reduction and spare no effort to reach the carbon neutral. Qingdao, Beijing, Hangzhou and Dezhou city have signed the *Daegu declaration* to fulfill the improvement of energy efficiency and renewable energy in order of reducing greenhouse gas.

In less than five years (2005~2010), research institutions for low carbon society in China have increased by folds from several. According to the name of the institutions which published study research articles, 18 research institutions have “low carbon” in their names and 37 research institutions have “climate change” in their names (CNKI search), most of which are established in the past 3 years mainly distributed in Beijing, Shanghai and Guangzhou etc.

Voluntary carbon trading has started in China. Now Shanghai Environment Energy Exchange, Beijing Environment Exchange and Tianjin Climate Exchange have started formal exchange and other exchanges are being actively prepared. Voluntary carbon trade volume in China in 2009 reached 5.2 million tons of CO₂^[24].



Fig. 4 Low carbon research institutions in China and low carbon practice of local governments

Some influential enterprises and enterprise associations in China have made efforts in and commitments to building a low carbon society. In the “White Paper on the State Grid Corporation of Green Development” issued in 2010, the State Grid Corporation proposed to basically build and complete the Strong Smart Grid in 2020, all out increase the capability to consume clean energies, reduce state grid line loss rate to 5.7%, make popularization rate of intelligent electric meters reach 100%, make electric automobile charging stations cover large and medium sized cities and increase electric automobiles by 30 million in 2020 compared with 2005. CO₂ emission will be reduced by 1.65 billion tons in 2020 compared with 2005.

China Building Materials Circulation Association issued the development road map for low carbon building materials in China in 2009 and proposed that CO₂ emission from the whole building materials industry will be reduced by 56% in 2012 compared with 2005, which means that carbon emission per 10,000 RMB added value for the building materials industry will drop to 7.33t/10,000 RMB. In the “2008 China Sustainability Reporting Guidelines for Apparel and Textile Enterprises”, China Textile Industry Association clearly proposed that Chinese apparel and textile enterprises need to define the total emission of greenhouse gases and control indices, measures and effects in their sustainability reports. Seven Chinese enterprises including China Mobile and Suntech have joined to UK’s Climate Group and they

signed the principle of the Climate Group to publish greenhouse gases emission information and reduce considerable greenhouse gases emission.

5 Deficiencies in the research and practice of low carbon society

Although China has gained significant development in the study on and practice of low carbon society, it faces many difficulties in realizing a low carbon society vision and presently the policymakers urgently need to resolve the following three problems:

- **China has not formulated a total CO₂ emission cap and a comprehensive low carbon society development scheme**

Chinese government has clearly made the commitment to reducing carbon emission intensity but many scholars think that intensity goal is affected by both economic growth speed and CO₂ emission, and it is very difficult to form the hard restriction for national economy and society development as well as formulate pertinent statistical, monitoring and evaluation methods. In addition, due to great difference of economic development and energy utilization among provinces in China, the intensity goal is difficult to be allocated fairly, equitably and reasonably and operability is low. At the same time, according to the experience in total SO₂ and COD emission control in the 11th Five Year Plan period, the efficiency of achieving total emission control goal is higher than intensity goal. Also, setting the total CO₂ emission control goal and dividing it into provinces not only can promote the development of voluntary CO₂ emission trade system in China but also help China eliminate regional rich-poor gap and carry out green development^[25]. Furthermore, China has not issued a low carbon society development road map and CO₂ emission goal for provinces and industries/sectors. A low carbon society development scheme with consideration of total emission goal, carbon tax and other comprehensive measures needs to be studied in depth and issued.

- **The role of cities in building a low carbon society is not brought into full play**

Cities are concentration area for population, architecture, traffic, industry and materials circulation and also high energy consumption areas and therefore it inevitably become a hot spot and major areas for greenhouse gases emission. The study report of “C40 Large Cities Climate Leadership Group” thought that cities emit 80% manmade greenhouse gases in the world and thus the rapid growth of greenhouse gases emission from cities is the important cause for the rise of global greenhouse gases emission. Although this conclusion is somewhat controversial, total direct emission of greenhouse gases from cities and indirect emission triggered by consumption in urban regions are undoubtedly enormous. Although many cities in China have started active planning for low carbon development and low carbon society, less than 2% of 655 cities (283 prefecture-level cities and 368 county-level cities, 2008) clearly implement low carbon development and low carbon society. Most

cities have not developed a relatively complete inventory of urban greenhouse gases. Additionally, Lack of method for the inventorying of greenhouse is also one of the factors that restrict the low carbon development in Chinese cities. Many cities still use IPCC methods to calculate carbon emission while it is an international common understanding that IPCC methods are not applicable to city scale^[26]. Therefore, establishing a set of guidelines on developing low carbon society in cities including methodology and indicator system is very necessary and is of important significance for pushing forward the development of low carbon cities in China. The development of low carbon cities is a key step in building a low carbon society in China.

- **Public awareness on low carbon is not sufficient**

Although “low carbon economy” and “low carbon development” have become popular in China, “low carbon” is only a noun for Chinese public to a large extent and the public knowledge of low carbon society is still at a low level. In 2007 Chinese Academy of Social Sciences conducted a survey for public environmental awareness from 3,001 urban and rural residents, only 41% knew greenhouse gases and greenhouse effect, ranking the fourth in environmental problem knowledge rate; seriousness of climate change also only ranked the fourth in environmental problems. The similar sample survey conducted by Horizon Research Consultancy Group in 2009 confirmed this conclusion. Chinese citizens’ knowledge of climate change problems still ranked the fourth in the 10 major environmental problems and only 6% respondents think that the public is responsible for climate change^[27]. World Bank investigated 13,518 people in 15 countries on their attitude to climate change in 2009 and only 28% Chinese respondents thought that climate change is a serious problem, lower than that of India and Iran. And China had the lowest rate among the investigated 15 countries^[28]. These investigations show that to build a low carbon society, China still needs to do a great deal of research and practice work on public propaganda, education and actively guiding the change of the public patterns of consumption and behavior.

6 Conclusion

China is a big greenhouse gases emission country and also a big developing country, thus China faces a dilemma in economic development and carbon emission control. The core tenet of low carbon society is to reconcile the development and carbon emission reduction goal. However, it does not emphasize only on the change of economic model but tries to create a completely new form of human society development through overall transformation of social mechanism, institutional design, regional planning and life style. Therefore, low carbon society theory has very important reference and study significance for China. In the key points of a low carbon society, China still has many deficiencies in shaping comprehensive low carbon society measures, such as low carbon cities and public awareness on and participation in low carbon. These have pointed out the key points in the future low

carbon society study and practice in China.

References

- [1] Japan-UK Joint Research Project. Japan Scenarios and Actions towards Low-Carbon Societies (LCSs)[R], Japan-UK Joint Research Project, 2008.
- [2] LCS-RNet. Low-carbon society research[R], LCS-RNet, 2009.
- [3] Skea J, Nishioka S. Policies and practices for a low-carbon society[J]. *Climate Policy*, 2008, 8(Supplement 1): S5-S16.
- [4] Hourcade JC, Crassous R. Low-carbon societies: a challenging transition for an attractive future[J]. *Climate Policy*, 2008, 8(6): 607-612.
- [5] Matsuoka Yuzuru. How to link modelling and practical steps to achieve a low-carbon society[C]. *UK/Japan-Achieving a Low Carbon Society*, 2007.
- [6] Fujino J, Hibino G, Ehara T, *et al.* Back-casting analysis for 70 emission reduction in Japan by 2050[J]. *Climate Policy*, 2008, 8(Supplement 1): S108-S124.
- [7] Gomi K, Shimada K, Matsuoka Y. A low-carbon scenario creation method for a local-scale economy and its application in Kyoto city[J]. *Energy Policy*, 2009, 38(2010): 4783-4796.
- [8] Shimada K, Tanaka Y, Gomi K, *et al.* Developing a long-term local society design methodology towards a low-carbon economy: An application to Shiga Prefecture in Japan[J]. *Energy Policy*, 2007, 35(9): 4688-4703.
- [9] Zhang Kunmin, Pan Jiahua, Cui Dapeng, *Theory of Low Carbon Development*. [M]. Beijing: China Environmental Science Press, 2009.
- [10] Zhuang Guiyang, *Low Carbon Economy: China's Development Road in the Background of Climate Change*[M]. China Meteorological Press, 2007.
- [11] China UNDP. *China human development report 2009/10*[R], UNDP, 2010.
- [12] Watson Jeremy. *Dongtan eco-city*[C]. *UK/Japan-Achieving a Low Carbon Society*, 2007.
- [13] Strachan N, Foxon T, Fujino J. Policy implications from the Low-Carbon Society (LCS) modelling project[J]. *Climate Policy*, 2008, 8(Supplement 1): S17-S29.
- [14] Barker T, Scricciu SS, Foxon T. Achieving the G8 50 target: modelling induced and accelerated technological change using the macro-econometric model E3MG[J]. *Climate Policy*, 2008, 8(Supplement 1): S30-S45.
- [15] Tapio P. Towards a theory of decoupling: degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001[J]. *Transport Policy*, 2005, 12(2): 137-151.
- [16] UNDP. *Human Development Report 2009*[R], UNDP, 2009.
- [17] IEA. *CO₂ Emissions from Fuel Combustion 2009*[R], IEA, 2009.
- [18] British Petroleum. *BP Statistical Review of World Energy*[R], BP, 2010.
- [19] UNDP, Renmin University of China. *CHINA HUMAN DEVELOPMENT REPORT 2009/10 China and a Sustainable Future: Towards a Low Carbon Economy & Society* [R], UNDP, 2010.
- [20] Topic Group of Energy Research Institute under National Development and Reform Commission. *China's Low carbon development pathways by 2050-scenario analysis of*

- energy demand and carbon emissions[M]. Beijing: Science Press, 2009.
- [21] 2050 China Energy and Carbon Emission Study Topic Group. 2050 China Energy and CO₂ Emission Report[M]. Beijing: Science Press, 2009.
- [22] Wang Weiguang, Zheng Guoguang, editor in chief. Annual Report on Climate Change Actions (2009) --The Road to Copenhagen[M]. Beijing: Social Sciences Academic Press (China), 2009.
- [23] Wang Jinnan, Yan Gang, Jiang Kejun, *et al.* The study on China's carbon tax policy to mitigate climate change[J]. *China Environmental Science*, 2009, 29(1): 101-105.
- [24] Hamilton Katherine, Sjardin Milo, Shapiro Allison, *et al.* State of the Voluntary Carbon Markets 2009[R], Ecosystem Marketplace and New Carbon Finance, 2009.
- [25] Guan D, Hubacek K. China can offer domestic emission cap-and-trade in post 2012[J]. *Environmental Science & Technology*, 2010, 44(14): 1055-1055.
- [26] Kennedy Christopher, Steinberger Julia, Gasson Barrie, *et al.* Methodology for inventorying greenhouse gas emissions from global cities[J]. *Energy Policy*, 2010, in press
- [27] Lo ALEX. China's Response to Climate Change[J]. *Environmental Science & Technology*, 2010, 44(15): 505-525.
- [28] The world bank. Public attitudes toward climate change: findings from a multi-country poll[R], The world bank, 2009.