

Analysis on Status of Developing Low Carbon Economy and Selection of Evaluation Index in China

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Abstract

With the process of industrialization and urbanization accelerating, climate warming caused by CO₂ produced by lots of fossil fuels consumption has been more and more serious, so developing low carbon economy has become a new economic model. Based on historical data and the background of low carbon economy, this paper firstly expounds the status of China's low carbon economy and secondly sums up existing problems according to the actual situation and gives a basic model of developing low carbon economy in China. Finally, this paper establishes an index system of evaluating the comprehensive level of low carbon economy according to the status of China's low carbon economy and the principles of selecting index.

Index terms— China; low carbon economy; status and development model; selection of evaluation index.

1 Introduction

With the China's economy rapidly growing and industrialization and urbanization accelerating, climate changes caused by a large number of fossil fuels consumption has brought about serious losses of social and economic development. Thus, for China, developing low carbon economy is a only way to achieve sustainable development. Kyoto Protocol promulgated as a legislation in 1997 referred to "Low Carbon" for the first time in human history. After that, every country in the world has been starting to strive to solve global climate problem while they develop their economy. China attaches great importance to global climate changes as the second largest energy producer and also the second largest emitter of carbon dioxide and has successively promulgated three programmatic documents: Outline of Nation's Long-term Scientific and Technological Development Plan, National Assessment Report on Climate Change and the Eleventh Five-Year Plan of State Environmental Protection and clearly has proposed that it is very essential to put the energy and environmental protection issues etc. on the first position of scientific & technological development. Soon after, China has formulated National Program on China's Response to Climate Change, which manifests China's efforts of developing low carbon economy.

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In 2006, Stern Report written by Nicholas Stern, a former chief economist in World Bank, indicated that 1% inputs of GDP per year will make the world avoid 5%-20% losses of GDP per year in future (Chen Ying, Pan Jiahua & Zhuang Ruiyang, 2007, pp.114-119).

In 2005, according to International Energy Agency (IEA) statistics, the global CO₂ emissions was about 27.136 billion tons and 99.7% were from the burning of fossil fuels, of which China accounted for 18.8% (IEA, 2006).

In 2007, the fourth assessment report of IPCC showed that the main source of greenhouse gases was the burning of fossil fuels, which had led to the result: the proportion of CO₂ emissions in the total carbon emissions was nearly 95.3% in 2004 (excluding CO₂ increase caused by deforestation and reduction of biomass). In this year, China's consumption of coal was about 2.3 billion tons, CO₂ emitted by carbon-based fuels was 5.43 billion tons, its ranking was No.2 around the world. Besides, compared with other countries, carbon emissions intensity

per GDP (that is CO₂ emissions per economic outputs) in China is very high. In 2002, the intensity was 605 tons/million GDP U. S. dollar, this number was 1.86 times of India, 1.69 times of Japan and 1.6 times of developed countries in Western Europe (shown in The term "Low Carbon Economy" first appeared in the UK Energy White Paper (a government document): Our Energy Future: Creating a Low Carbon Economy, this book pointed out low carbon economy can gain more economic outputs and also create opportunities for development, application and export of advanced technology through less consumption of natural resources and less environmental pollution (Li Huifeng, 2010, pp.40-42). Therefore, low carbon economy is a economic development model whose characteristics are lower energy consumption, lower pollution, lower emission and higher performance, higher efficiency, higher benefit. It is the fifth industrial revolution after steam engine, electrification, atomic energy space technology and new energy and also the game rules of ecological civilization society in future (Fan Dejun). It will be bound to profoundly affect the way of production and life in today's and future society. For China, "low carbon" is a new growth point and turning point to develop its economy much better and also a emerging power to further achieve sustainable development, which has important practical significance.

Thus, how to better develop low carbon economy has become a greatly significant issue of developing economy stably which China and even the world are facing.

2 II. The Research Status of Low Carbon Economy in China

With low carbon age coming closer, competition among countries must be accompanied by competition of low carbon technologies. As the largest developing country, China is being faced with a major task of economic development, energy and climate changes.

Scholars He Juhuang, Shen Keting etc. (2002, pp.39-47) pointed out that too early decreasing CO₂ emissions will certainly affect China's economic development. Chen Wenying, Gao Pengfei etc. (2004, pp.744-747) also pointed out that when the carbon reduction rate is 0%-5%, the loss rate of GDP is 0%-25%. Wang Zheng, Li Huaqun etc. (2007) Therefore, to accomplish this challenging goal, developing low carbon economy is the only way. But as the largest developing country, developing low carbon economy in China is bound to be a great challenge. a) Existing problems First, energy consumption structure of coaldominated is a major issue that China is facing in order to develop low carbon economy. Reserves of petroleum and natural gas in China only account for 1.3% and 1.2% in world's total reserves. As the main energy, reserves of coal is 114.5 billion tons, accounting for 11.02% in world's total reserves, its proportion is up to 70% in energy structure, but the greenhouse gas emissions caused by coal is about 80%. And China's extensive mining model makes resources waste seriously and the utilization rate is low efficiency. The total utilization rate of energy of China is around 33%, lower about ten percentage points than developed countries (Wang Lijin and Yi Qihong, 2010, pp. [16][17][18][19].

China has been the world's largest coal consumer and the second largest petroleum consumer, the petroleum depends on foreign is up to around 50%. For a long time, China's technological system on the basis of coal, petroleum etc. fossil energy and technological innovation and institutional innovation based on that system make China form a "Carbon Lock-in" state (Sun Gefei, 2010, pp.9-10).

According to China's energy conditions, by 2020, the proportion of coal will still keep above 60% in energy structure. Natural gas' CO₂ emission coefficient is only equivalent to 60% of coal's, so the proportion of coal consumption is bigger, the intensity of CO₂ emissions is higher, which will make the feature of "high carbon" very obvious in the process of economic development in China.

Second, China's industrial structure exists unreasonable phenomena. China's mainstay economy is still secondary industry, services industry is comparatively lagging behind, thus, this industrial structure is extremely unfavorable. According to related statistics, China's energy intensity increased to 4.77 ton of SCE /10000 yuan in 2007 from 4.21 ton of SCE/10000 From 1990 to 2003, China's GDP growth accounted for 10% in the world, but energy consumption growth accounted for 27% and greenhouse gas emissions growth accounted for 34% (Huang Dong and Li Huaixia, 2009, p.48). In 2007, the proportion of coal in primary energy was only 27.8% in the world, coal consumption ratio in most developed countries were less than 20%, but coal consumption ratio in China was up to 69.5% (Du Feilun, 2009, p.30). So China's "high carbon" structure is a great challenge to the development of low carbon economy.

Third, China is being in a extraordinary period of rapid development of industrialization, urbanization and modernization, which makes lots of high-carbon gases emissions difficultly avoid. As the largest developing country, China's theme is still development in half of the 21 st century, much more infrastructure makes energy demand increasing. Total energy consumption in 2007 rose to 2.656 billion ton of coal equivalent from 1.386 billion ton of coal equivalent in 2000, the average growth rate per year was 9.7%. By 2020, total energy demand will reach above 5 billion ton of coal equivalent (Li Huifeng, 2010, pp.40-42). In this period, market shows a seller's market characteristic, so enterprises are less aware of low carbon economy technological innovation and product innovation, these phenomena further aggravate China's energy demand and "high carbon" feature.

Fourth, New China established is not a long time, so comparatively backward total technological level also hampers low carbon economy development. At present, China's energy production & utilization, industrial production technology, technological innovation & development capacity and manufacturing capacity of key equipment have a wide gap compared with developed countries. Strictly speaking, China's market economy started from 1992, only 18 years until 2010, own capital accumulation is not sufficient, so China must make

efforts to increase opening-up to attract foreign investment. It was estimated that calculated by GDP in 2006, China needs 25 billion USD funds every year in order to step into "low carbon" from "high carbon".

Based on above four aspects, author thinks China needs to establish a low carbon economy development model which adapts to its own situation and a index system which objectively evaluates its low carbon economy development level.

3 b) low carbon economy Development model

Considering existing problems of developing low carbon economy in China, the scholar Li Huifeng (2010) thought China's low carbon economy model is different from free-market economic model and environmental governance model absolutely controlled yuan in 2001, energy consumption level is higher and higher (Li Huifeng, 2010, pp.40-42). by government but an interactive model which government, market and micro-economic subjects (enterprises and residents) participate together. Shown in Figure ??.

4 Figure 1. Low carbon economy model in China

However, author thinks China's low carbon economy model should be a linkage model which makes government be at the centre and microeconomic subjects and market be two wings (shown in Figure 2), and the status and role of government, microeconomic subjects and market should not be a simple linear parallel relationship shown in Figure ??. First, in the model shown in Figure 2, government need to guide and direct market system construction and micro-economic subjects behavior and also must formulate low carbon economy strategies, plans and related legal systems to supervise and control low-carbon market in order to make the market stably and orderly develop. At the same time, low-carbon market and micro-economic subjects provide timely feedback to government. This interactive and linkage model can make the low carbon economy development more effective. Second, low-carbon market system should include the carbon emissions trading market with Chinese characteristics which promotes better development of low-carbon technologies and industries and purposefully guides low-carbon awareness and behavior of micro-economic subjects. At the same time, micro-economic subjects provide timely feedback to market system to make the low-carbon market system further improve and develop.

Third, "visible hand" and invisible hand" both together guide micro-economic subjects to approach to low-carbon patterns to make enterprises upgrade industrial energy-saving technologies and form the lowcarbon technological development and innovation system. Besides, developing low-carbon products plays an important role in guiding consumers' lifestyle with low-carbon.

The model shown in Figure 2 more greatly emphasizes the force formed by government, market and micro-economic subjects and breaks the shackles that overemphasizes government's role. They of three can promote and coordinate each other.

In order to implement the linkage model, some effective strategies must be formulated: 1. Government need to actively "digest and absorb" the development concept of low carbon economy and formulate the national strategy and corresponding legal security system as soon as possible. At the same time, government also strengthens international cooperation and learns from foreign experience in environmental regulations. Considering the pressure of RMB appreciation and the rising prices of raw material, China's manufacturing should concentrate on upstream industrial chain (strategic decisionmaking, R&D, etc.) and downstream industrial chain (brand-building, customer service, etc.) and transfer the middle parts to surrounding low-cost countries to resolve financing obstacles etc.. Besides, all local governments must do "carbon budget" from now and consider the income & expenditure of funds and carbon emissions and absorption.

Article 22 in the Central Authority Recommendations on Formulating the Twelfth Five-Year Plan says that actively responding to global climate change, greatly reducing energy consumption intensity and CO₂ emissions intensity as binding indicators and effectively controlling greenhouse gas emissions. 2. Establishing a carbon trading market in China by using of market mechanism. Kyoto Protocol establishes three compliance mechanisms: Emissions Trading (ET), Joint Implementation Mechanism (JI) and Clean Development Mechanism (CDM). These three mechanisms' purpose is to try to transfer and trade carbon credits among countries as a commodity, the transaction object is the remaining carbon credits. And the ultimate means to obtain the remaining carbon credits is to use of low-carbon technologies, but low-carbon technology innovation and progress need to use of market incentives.

At present, only Beijing, Tianjin and Shanghai have established environmental trading agencies but still in the primary stage and not real financial transaction platform. Establishing the carbon trading market can attract more international forces to participate in China's Clean Development Mechanism Project and businesses also can profit through the sale of carbon emission rights. 3. Enterprises and residents need to advocate lowcarbon production, life and consumption patterns. Low carbon is an effective way of consuming less resources and improving the ecological environment and also a new way of life. Now, some commodities in the supermarket are clearly marked "carbon footprint" (carbon emissions label), which is the most widely labeling system in developed countries. China also should establish this labeling system as soon as possible to advocate low-carbon lifestyle of "reasonable material consumption". 4 (2009) thought based on the practical needs of economic development, the natural carbon sequestration activities driven by agriculture, forestry and other land use (AFOLU) will become an extremely important topic of developing low carbon economy on condition that carbon emissions caused by

fossil fuels still inevitably continue to increase all over the world. Pan Jiahua, Zhuang Guiyang and Chen Ying (2003) thought the reduction capacity of China's forest carbon sequestration exists regional differences, however, if there is financial security, its reduction potential will be huge. Notes :

(1) The reduction potential of carbon sequestration is permanent carbon storage capacity; (2) Carbon input cost is the investment calculated by discounting in two to three years in early time of blockading mountains and cultivating trees.

Information source : Sathaye and Ravindrana, 1998.

5 IV.

Establishing the Low Carbon Economy Evaluation Index System a) The principle of selecting indexes These selected indexes must be able to objectively evaluate the China's low carbon economy development level, so selecting indexes must follow necessary principles and consider some major factors affect China's low carbon economy development.

These necessary principles are included: (1) conform to the objective laws and development requirements of low carbon economy to provide objective evidence for scientific decision-making; (2) consider the comprehensiveness of these selected indexes to include enough information; (3) conform to the logic and hierarchy when selecting indexes to reflect the major characteristics and the development trends of low carbon economy; (4) according to the dynamic principle of low carbon economy development, these selected indexes can be made the timely adjustment with economic and social development but must be relatively stable in a certain period. So these indexes can reflect the status and the dynamic changes of low carbon economy development; and (5) these selected indexes can be well quantified to qualitatively and quantitatively analyze.

6 b) Selecting indexes

When selecting indexes, author mainly considers the source of CO₂ emissions. CO₂ comes mainly from the burning of fossil fuels. Based on data in 2005, China's primary energy consumption was 2.2 billion ton of SCE, of which the proportions of coal, petroleum, gas and hydro-power were 68.7%, 21.2%, 2.8% and 7.3%. The estimated CO₂ emissions reached 5.1 (1), ij means the weight of each index, ij means index value without dimension; "i" means the serial number of the second level index, "j" means the serial number of the third level index.

The weight of each index can be calculated by Principal Component Weights Definition or Delphi Method (must consult 15-20 experts at least).

V.

7 Conclusion

By summing up the previous research achievements, author improve the China's low carbon economy development model and establish the evaluation index system which can evaluate China's low carbon economy development level and provide a general calculation method. Besides, considering China's actual situation, further improving the statistical methods and unifying the assessment criterion are very important, which makes the evaluation system more scientific and objective.

In short, as a newly economic development model, low carbon economy is the only way of achieving sustainable development for China. But in practice, government, market and micro-economic subjects must coordinate each other in order to achieve a win-win for China's economic development and low carbon goal.

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Figure 1: Figure 2 :

Figure 2: Table

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Figure 3:

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Figure 4: Table 2 :

Statistics show

China's nuclear power generating capacity was 68.4 billion kwh in 2008, compared with thermal power generating capacity by coal, reducing CO emissions more than 80 million tons. Developing new energy and optimizing the energy structure are significant measures to gradually change the coal-dominated energy structure. In addition, China need to enhance forest carbon sequestration capacity (Wen Jiabao, 2009) (Forest carbon sequestration is that forest eco-system absorbs CO₂ in the atmosphere and fixes CO₂ in vegetation or soil which excludes CO₂ released into the atmosphere by soil & vegetation-themselves respiring). Forest is a huge storage of CO₂, increasing 1% of forest cover can absorb and fix carbon 60 million tons to 710 million tons.

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Figure 5:

3

Reduction methods of carbon sequestration	Reduction potential of carbon sequestration (tC/hm ²)	Input cost of per ton carbon (USD)
	North and Northwest in China	
Blockade mountains and cultivate trees	13.0	1.3
Artificial fast growing forests	55.0	1.3
Agriculturalization and forestry industrialization	15.0	16.3
	South, Southwest and Northeast in China	
Blockade mountains and cultivate trees	13.9	3.5
Artificial fast growing forests	71.0	5.0
Agriculturalization and forestry industrialization	6.0	9.8

Figure 6: Table 3 :

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The first level index	The second level index	The third level index
Low carbon economy development level	Energy structure	The proportion of clean coal in total coal energy
		The proportion of new energy and renewable energy in total energy
		The proportion of fossil energy in total energy
		The utilization efficiency of total energy
	Transport sector support	

Figure 7: Table 4 :

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