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Overview of Low-carbon Economy Research

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Abstract The paper has a detailed literature review in low-carbon economy research of academic circle in our country from three aspects that are conception and connotation of low-carbon economy, necessity and urgency of developing low-carbon economy and path choice of realizing low-carbon economy in our country. low-carbon economy is the "green economy" that obtains the maximum output by discharging minimum greenhouse gases with the main characteristics of "three low and three high" that are low energy consumption, low pollution, low discharge and high effect, high efficiency, high benefit. To China, developing low-carbon economy is the inevitable choice in realizing peaceful rising and sustainable development as a responsible large country. It conforms to world trends and corresponds to China's actual conditions. Finally, the paper makes a overview of the path choice in realizing low-carbon economy in our country from eight aspects-integral countermeasures and suggestions, technology innovation, consumption pattern innovation, policy innovation, environmental and financial innovation, building low-carbon city, establishing carbon trading market and developing low-carbon agriculture.

Key words Low-carbon economy, Policy suggestion, Path choice, China

The idea of "low-carbon" economy starts from the consideration of climatic change and energy security. But along with the continuous progress of progress, its connotation gets further deepening and development. Domestic scholars offer their own understanding and analysis of low-carbon economy from different angles. The author has a detailed literature review in low-carbon economy research of academy circle in our country from three aspects that are conception and connotation of low-carbon economy, necessity and urgency of developing low-carbon economy and path choice of realizing low-carbon economy in our country.

1 Conception and connotation of low-carbon economy

The conception of low-carbon economy is first put forward in the white book-*Our Future Energy – Constructing low-carbon Economy* of Britain.

Zhuang Guiyang (2005), who is a relatively early domestic scholar in low-carbon economy research, thinks that he (2005) thinks that low-carbon economy means to carry out a energy revolution depending on technology innovation and policy measures and establish an economic development mode which discharge less greenhouse gases so as to slow down climatic change. The essence of low-carbon economy is the issue of energy efficiency and cleaning energy structure. The core is energy technology innovation and institutional innovation. The target is slowing down climatic change and promoting sustainable development of human^[1].

Xie Jun'an and others (2008) consider that the connotation of low-carbon economy comprises three aspects. First, low-carbon economy is put forward relatively to high-carbon economy which bases on unconstrained carbon intensive source

of energy mode of production and energy consumption pattern; Second, low-carbon is relative to new energy and economic development patterns which based on fossil energy; Third, low-carbon economy is said relatively to man-made carbon flux, it is a kind of self rescue in solving carbon unbalance of earth ecosystem caused by man-made carbon flux. low-carbon economy in essence belongs to globally carbon neutral economy^[2].

Li Sheng and Chen Xiaochun (2009) point out that low-carbon economy includes low-carbon production, low-carbon circulation, low-carbon distribution and low-carbon consumption in connotation. The core is, on the basis of market mechanism, through policy innovation and system designing, improving energy saving technology, reproducible energy technology and greenhouse gas emissions cutting technology, establishing low-carbon energy system and industrial structure, and realizing low-carbonization of production, circulation, distribution and consumption^[3].

Liu Xiliang (2009) thinks that in modern significance, low-carbon economy is a kind of rational balance made by human itself of the relation of economic growth and welfare improvement, economic growth and environmental protection in human social development process, and a kind of rational cognition of the harmonious relation of man and nature, man and society and man to man. It is the ecological civilization after original civilization, agricultural civilization and industrial civilization. It is also a new energy revolution after industrial revolution and information revolution^[4].

Yuan Nanyou (2010) thinks that the connotation of low-carbon economy is very abundant. low-carbon economy is not only a kind of economic growth idea, but a kind of economic growth pattern. It is the result of the game of the country and a politicized scientific problem. Meanwhile, it is a comprehensive issue involved with economy, society and environment^[5].

Fan Jianhua (2010) considers that it needs to understand the abundant connotation of low-carbon economy deeply from five aspects. First, on the mastering of relation between carbon

emission and economic growth, low-carbon economy is inevitable product of resource environment and economic development. Second, on the development of low-carbon economy, enterprises are the main body of low-carbon economic development. Third, on the content, low-carbon economic growth mainly constructs low-carbon industrial development pattern and low-carbon regional development pattern. Fourth, on the target, low-carbon economy is mean to balance the relation between resource environment and economic development, and finally form the maximum efficiency in use of energy and resources, optimal ecological environment and maximum welfare of people. Fifth, on the path choice of low-carbon economic development, energy conservation and emission reduction must be carried through^[6].

It can be seen that the idea of "low-carbon" economy starts from the consideration of climatic change and energy security. But along with the continuous progress of progress, its connotation gets further deepening and development. Domestic scholars offer their own understanding and analysis of low-carbon economy from different angles. Although in different angles and differences existing in their presentation ways of low-carbon economy, the connotation is much the same, that is, low-carbon economy is the "green economy" that obtains the maximum output by discharging minimum greenhouse gases with the main characteristics of "three low and three high" that are low energy consumption, low pollution, low discharge and high effect, high efficiency, high benefit.

2 Necessity and urgency of low-carbon economic development

Zhuang Guiyang (2005) explains that Chinese economy should choose low-carbon development road from external drive and internal demand. External drive comes from the requirement to cut greenhouse gas emission from international society. The developing China must prepare for meeting the challenges in post-kyoto times. On the aspect of internal demand, China now faces with huge pressure of greenhouse gas emission cuts, energy security and ecological security face with threat. Therefore, the only choice for China is converting pressure into motive power and looking for low-carbon development road^[1].

Hu Congyang (2008) introduces the process of low-carbon economic development in developed countries such as Britain, Japan, France, Sweden and so on, analyzes its revelation to Chinese development. He also points out that it is a win-win choice for our country to have the low-carbon economic development road, because it can realize energy conservation and emission reduction at the same time as development. It can not only dissolve international pressure, but also corresponds with our own actual national conditions. low-carbon economy should be strived to develop in China^[7].

Fu Yun and others (2008) think that low-carbon economy is the best economic pattern to cut down greenhouse gas emission and cope with global warming. It is very urgent for China to develop low-carbon economy with at least three reasons. First, China faces with large pressure of greenhouse gas emission re-

duction. Second, energy security in China faces with serious threat. Third, the utilization of resources in our country is super-normal, and ecological environment has deteriorated gradually^[8].

Song Deyong and Lu Zhongbao (2009) point out that, to China, developing low-carbon economy is the inevitable choice in realizing peaceful rising and sustainable development as a responsible large country. It conforms to world trends and corresponds to China's actual conditions. If we don't take action as soon as possible, our country is high possible to be "locked" and "solidified" in high-carbon production mode and consumption pattern. This will not only make us pay more expensive resources and environment, but also lose the historical opportunity to catch up with and surpass developed countries and realize leapfrog development^[9].

Zhang Kunmin (2010) considers low-carbon economy is the only road to sustainable development. We should not just see the external pressure, we should pay more attention to internal demand. He explains that low-carbon economy is corresponding with our internal demand from five aspects-energy resource endowment, development stage, current flow, locked-in effect and marginal cost. He also points out that we should have the sense of urgency to develop low-carbon economy, and the key is to solve transformation of economic growth pattern and current serious problems, and economic policy in pilots and structural reform should be followed up^[10].

In addition, Jiang Yimin (2008)^[11], Feng Zhijun (2009)^[12], Liu Zhaozheng (2009)^[13] describe the necessity of developing low-carbon economy in China respectively from economic sustainable development, strengthen international competitiveness of domestic products and the trend of world economic development.

3 Path choice of realizing low-carbon economy in our country

3.1 Integral countermeasures and suggestions Fu Yun and others (2008), on the basis of overview of low-carbon economy theory and practice at home and abroad, from macro, middle and micro level, demonstrate that low-carbon economy development pattern has the development direction of low-carbon development, the development pattern of energy saving and emission reduction and the development method of carbon neutrality and technology. He puts forward the policy measures to implement low-carbon economic development pattern-giving priority to energy saving, improving energy utilization efficiency; low-carbonizing fossil energy, rapidly developing renewable energy sources; setting up carbon funds, incensing research and development of low-carbon technology; establishing carbon trading mechanism in the whole country^[8].

Research group of combating climate change of Development Research Center of the State Council (2009) points out the emphasis and suggestions of developing low-carbon economy, it includes ten points. First, make overall plan to create conditions for low-carbon development. Second, optimize industrial structure and develop low-carbon industries. Third, develop and expand circular economy, focus on industrial energy saving and emission reduction. Fourth, increase support in de-

velopment and utilization of new energy and renewable energy. Fifth, attach importance to research, development and technical reserve of low-carbon technology. Sixth, encourage consumption as well as object wasting. Seventh, plan and establish with low-carbon idea, carry out low-carbon economy pilot. Eighth, formulate related policies, form an effective system of low-carbon development. Ninth, strengthen international cooperation, research and develop low-carbon technological system. Tenth, publicize and educate low-carbon economy widely, improve cognitive level of leaders and people^[14].

Xie Zhenhua (2010) emphasizes that developing low-carbon economy is the common view in most countries. But the development stages of different countries are different, national conditions are different, and understand and path choice of low-carbon economy are not the same. As a developing country, development is still the first important business. We must close integration with own stage of development and actual national conditions when develop low-carbon economy. He points that we should push forward low-carbon development from six aspects-strengthen policy guidance and macro coordination, put each policy and measure into practice, arrange the development of low-carbon economy pilot, improve related capacity building of developing low-carbon economy, enhance propaganda and education and improve the awareness of the whole people and organize international exchange and cooperation^[15].

In addition, Bao Jianqiang (2008)^[16], Guo Yin (2009)^[17], Huang Dong (2009)^[18], Wang Wenjun (2009)^[19], Zhang Kun-Min (2010)^[10], Li Yang (2010)^[20] and some other scholars also put forward their policies and suggestions to develop low-carbon economy on the basis of fore studies. The contents are almost the same, generally include establishing perfect related laws and regulations, adjusting the industrial structure, optimizing energy structure, pushing forward low-carbon technology, building low-carbon cities, actively developing renewable energy sources and exploiting carbon sink potential.

Pan Jiahua (2009) considers that, if we depend on adjusting the industrial structure and energy structure, due to the constraint of current stage of development, energy resources endowment, capital and technology, the development space of low-carbon economy is extremely limited. So, the main points of low-carbon economic development are the following points. Improve energy efficiency, develop renewable energy sources and guide consumer's behavior. Except the above three points, as a kind of technology choice, we can continue to research and develop carbon capture and sequestration technology to make it has business feasibility in the future. This is strategic investment. Besides, we can also use international business to develop low-carbon economy^[21].

3.2 Technological innovation Xin Li (2009) thinks that the core of developing low-carbon economy is research and development and extensive application of low-carbon technology. From the technological innovation angle, she analyzes the similarities and differences between low-carbon technology and traditional new technology, transformation of energy utilization patterns and transformation of social development patterns.

Meantime, she refers to international and domestic successful experience of developing and applying low-carbon technology and puts forward a series of polices and suggestions. It includes: to lead research and development, application and dissemination of low-carbon technology by theoretical innovation and institutional innovation; to establish related policies and laws and regulations to normalize the application and dissemination of low-carbon technology; to carry out a series of laws and regulations in capital input; to encourage the establishment of market transaction institution and multinational corporations of low-carbon economy; to encourage popularization of the knowledge of low-carbon economy and build a low-carbon social atmosphere; to work out detailed and operable screening standard of low-carbon technology, the core is carbonic emission reduction potential and technology maturity and attaching importance of cost performance; to know the existing equipment and infrastructure and demand of each department and estimate expenses risk that could afforded by manufacturer, to make experiments in pilot before popularization^[22].

Wang Wenjun (2009) thinks about the tech-economic paradigm of low-carbon economy on the basis of referring the fore-achievements. He points out that technology and systems are the core factors to put low-carbon economy into practice. Therefore, it conduces to rapid popularization and application of low-carbon economy by analyzing low-carbon economic paradigm system which combines by source control, process control and target control. He thinks that the realization of low-carbon economy should rely on technology first. We can only stop pollutant produce from the source by excellent technology guarantee. Secondly, we should rely on systems, especially polices which are good for low-carbon economy development. Moreover, we should rely on public actions^[20].

Yang Fang (2010) considers developing low-carbon economy is a long-term, arduous and complicated system engineering, and technological innovation occupies a decisive position. Promoting technology is the core of developing low-carbon economy. She analyzes Chinese low-carbon economy development from the angle of promoting energy technology progress, and points out that, at present, China can make quick progress in energy saving technology in the field of electric power, automobile, heavy industry, waste management, building, agriculture and forestry, city planning and so on. In addition, many new energy and energy saving and emission reduction technology is commercialization or close to commercialization. The key is how to encourage development and application of technology by marketing mechanism and effective energy and environment policies. She also puts forward corresponding suggestions: to push forward price reform to make the price of energy influence the decisive action for producer and consumer, and to push forward development of low-carbon industry; to increase research input of low-carbon from government, and to improve the proportion of energy research and development input; to create a fine system environment and supporting policies for the development of new energy and low-carbon technology^[23].

3.3 Innovation of consumption patterns Tan Juan and

some others (2009) points out that low-carbon consumption pattern is the fundamental demand in the process of human social development. In the current conditions of our countries, the connotation of generalized low-carbon consumption pattern includes five levels. First, "constant temperature consumption", the emission of greenhouse gas in consumption process is the lowest. Second, "economical consumption", consumption of resource and energy is the minimum and the most economical. Third, "safe consumption", health hazard of consumer and human living environment caused by consumption result is the minimum. Fourth, "sustainable consumption", the harm to human sustainable development is the minimum. Fifth, "new-field consumption", to turn to consume new energy, encourage to develop new low-carbon technology, research and develop low-carbon products and expand new consumption field^[24].

Chen Xiaochun and some others (2009) consider that the consumption field change brought from development of low-carbon economy is not formed naturally. The change of economic foundation needs consumers to constantly overcome the consumption propensity formed in a long term. It can only take continuous consumption guide and strive to low-carbon and recycling of consumption to realize the transformation from "high-carbon" economy to "low-carbon" economy. They also put forward corresponding suggestions to guide consumption actions. Guide reasonable consumption of families and encourage learning consumption; Guide personal cultural consumption and appeal to consumption justice; Guide low-carbon production and consumption of enterprises and support environmental protection enterprises; Government should guide consumption reasonably and insist on low-carbonization^[25].

3.4 Policy innovation Li Sheng and others (2009) put forward that how to scientifically formulate, execute and estimate public policies is very important to the development of low-carbon economy. At present, China should systematically innovate related public economic policies from the angle of policy chain, so it can promote the development of low-carbon economy effectively. It includes innovating security policies of national energy, related policies in industry, economy and finance, social policies participated by citizens, technology and talent policies, consumption policies and cultural policies^[3].

Song Deyong and others (2009) point out that the present low-carbon policies in our country mainly give priority to administrative means like "command-control". The financial and tax policies are not flexible enough, and has a relatively big difference with the policies which give priority to market in developed countries. Therefore, the low-carbon economic policy system in our country has to keep up with the process of market reform. The design of policy tools should transform from relying on administration means mainly to relying on market mechanism mainly. First, we should make sure that the low-carbon economic policy system in our country has to keep up with the process of market reform, and realize the transformation from "ruling of man" which depends on "leaders attach importance and put into practice" to "ruling of law" which depends on laws and systems. Second, on the choice of specific policy instru-

ments, we should transform from administration means mainly relying on administration means to policy instrument mainly relying on market mechanism. Third, we should improve existing low-carbon statistic, monitoring, estimating and examining system with main form of target responsibility system. Fourth, we should express media and public effect and sound market economy moral system. In a word, the policy instrument innovation of low-carbon economy in our country should go through a trial and error procedure of "design-operate-feedback-amend-perfect", gradually make the potential and invisible pressure of low-carbon economy domination, materialization and standardization, reduce cost and risk of developing low-carbon economy, increase profit of developing low-carbon economy and promote realizing low-carbon economy target in the whole society^[9].

Chen Xiaochun and other think analyze barriers in developing low-carbon economy in our country from the angle of weakness of policy implementation and hope to push forward low-economic development through strengthen administration executive force. Take legal, economic and administrative means to ensure policy implementation. Make a scientific decision according to national conditions in contemporary China. Enhance management by objectives and strengthen administrative accountability. Fully express social organizational strength. Push forward political restructuring and deepen restructuring of government administration. Construct scientific assessment system of work performance^[26].

3.5 Innovation of environment finance Ren Weifeng (2008), from the angle of environmental finance, summarizes research and practical experience home and abroad and discusses various ways of innovation of environmental finance. He thinks that, in order to promote low-carbon economic development in our country, it is very necessary to push forward environmental finance construction. We must construct corresponding incentive mechanism at the institutional level and push forward the establishment of environmental finance idea and related training. Government should make consideration of financial factors when formulate a series of laws, regulations, policies, rules and standards related to environment, and should not think confining to existing financial system. It should encourage financial institution such as bank, fund company and so on to improve environmental responsibility awareness, strengthen activity to capture business opportunity of low-carbon economy, push forward the growth of environmental finance suits to China's actual conditions^[27]. Li Fang (2010) point out that financial service must come first when developing low-carbon economy, and puts forward three suggestions in developing low-carbon financial development. First, develop multi-style financing channels and patterns of low-carbon economy, it is the necessary supporting financial service of low-carbon economy at present. Second, give policy support to small and medium sized enterprises which pay attention to energy saving and environment protection. Third, give policy support to commercial banks launching low-carbon finance^[28].

3.6 Constructing low-carbon city Xia Kunbao (2008) points out that low-carbon city means carrying out low-carbon

economy in cities. In order to build low-carbon city, the following policies and measures are needed. low-carbon production, carry out sustainable production mode. low-carbon consumption, carry out sustainable consumption pattern. Control developing speed of high-carbon industry, accelerate economic structural adjustment and improve development quality. Carry on international cooperation and bring in low-carbon technology. Developing low-carbon city should attach importance to urban planning, building energy efficiency, environmental impact assessment and some other fields^[29]. Xin Zhangping and Zhang Yintai (2008) point out that low-carbon city is an inevitable process of developing low-carbon development. They explain the road of constructing low-carbon city-application of new energy technology, application of clean technology, green planning, green building and low-carbon consumption. They also point out that construction of low-carbon city should include the following aspects. Developing low-carbon energy is the basic guarantee to build low-carbon city. Clean production is the key link of building low-carbon city. Cyclic utilization is an effective method in building low-carbon city. Sustainable development is the fundamental direction of building low-carbon city^[30].

3.7 Setting up carbon trading market Guo Yin and Wang Minjie (2009) point out that we should make full use of our broad prospect in carbon trading market when developing low-carbon economy, develop international carbon sink market actively, carry out management standard of carbon trading market as soon as possible and start to cultivate native carbon-trading merchants which are familiar with international carbon-trading rules^[18]. Yue Lang (2010) considers that, in order to effective cut down emission of CO₂, setting up a global carbon emission reduction market is an effective method. The cost of Chinese carbon emission reduction is comparatively low, many fields have plentiful emission reduction potential. Meanwhile, Chinese emission reduction market is very large^[31].

3.8 Developing low-carbon agriculture Wu Yiping and Liu Xianghua (2010), in accordance with the self-characteristics of agricultural ecological system, combining features of low-carbon economy and low-carbon agriculture, put forward the developing road of low-carbon economic development. Innovate agricultural biotechnology and engineering and develop carbon sink agriculture; Use advanced modern agricultural technology and build resources-saving agricultural production system; Push forward plantation and cultivation and integrated business operation, develop agricultural products processing park and push forward energy saving and emission reduction of related industrial clusters. Optimize institutional environment of low-carbon agricultural development by these methods, and finally realize rapid and healthy development of low-carbon agriculture in our county^[32].

4 Epilogue

As a big developing country, China is being in the process of high-speed industrialization. How to properly deal with the relations between social economic development and low-carbon economic transformation has become a significant subject with

universal concerns. About the issue of low-carbon economy, some domestic scholars have put forward some valuable opinions, we should makes efforts in adjusting industrial structure, optimizing energy structure, pushing forward low-carbon technology, building low-carbon city, innovating consumption patterns and innovating policies. This paper has summarized some representative viewpoints and is conducive to further research about this issue.

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of rural households. With the increase of income, rural households' credit demand will decrease initially and then increase. When the income level of rural households has surpassed the certain point, rural households tend to increase investment by using credit and loan to improve income. Therefore, the government should encourage rural labor to change the current small scale production mode and push rural households to take non-agricultural jobs. In addition, the efficient transform can improve the low agricultural production, increase the farmers' income and fully display the functions of rural labors.

4.2.2 Increasing the reservation of rural labor resources. The impact of education accepted by the rural householders on the credit demand is significant. The impact is not only directly and positively, but also promotes the non-agricultural tendency and the growth of annual income of rural households through indirect way. So, through education, training and other ways to increase human capital reserve funds is an effective to enhance credit availability farmers the long run. Science and technology through the promotion and talent will bring rural areas to help farmers improve their learning ability and capabilities, and can greatly improve the quality of farmers.

4.2.3 Strengthening the promotion on rural credit cooperatives and increasing the quality of services. Understanding of rural credit cooperatives also has an important impact on the farmers' credit needs. In order to enrich the knowledge, financial experience and to guide farmers to actively anticipate the loan system through the formal financial situation, more promotion of rural credit cooperatives should be done; other ways, likely credit policy, range of services, service orientation, service object and other aspects of information dissemination to rural areas, peasants and rural cadres to enhance the visibility of rural credit cooperatives. Meanwhile, the rural credit cooperative should improve the efficiency of loan; provide better financial services and enhance its social reputation. The credit demand of rural households is characterized into decentralization, small scale, flexible period (the span of the credit demand on

agricultural production is long, while the span on non-agricultural production and living is short), high risk and hard to supervise. Based on the current financial services and products, new regulations should actively been explored to satisfy the rural credit and loan demand. The current existing model of " rural credit cooperative + rural cooperative organization + rural households" can guarantee the accessibility of loan for rural households and maintain the simplification of credit process, but this still needs further development.

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