

**International Economics**

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**DEVELOPMENT
OF CIRCULAR ECONOMY MODEL:
THE CASE OF CHINA****Abstract**

In today's world, resource shortages and environmental problems have gradually become insurmountable obstacles to the economic development of all countries in the world, which is also particularly true for China. The traditional economic model of high energy consumption and high emissions can no longer meet the needs of current economic development. Therefore, the strong vitality of the economic model is particularly important. The author has determined the significance of circular economy to sustainable development of China. The evolution of China's circular economy has been analysed, while the strengths and weakness of the Chinese model have been highlighted. The paper substantiates directions for future development of circular economy in China in the context of innovations, regulatory support, recycling, pilot projects of «waste-less city», and partnerships between the authorities, entrepreneurs and the public.

Key words:

circular economy model; China's economy; development status; practical application; conceptual innovation.

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3 figures, 2 tables, 27 references.

Introduction

At the turn of the century, in the 1990s, with the continuous deepening of the concept of sustainable development, sustainable development strategies became the guiding ideology for the development of all countries in the world. Developed countries regarded the advent of circular economy as an important way to implement sustainable development strategies.

In the 1980s, in the context of the global environment, along with the process of industrialization, the concept of circular economy was introduced to China along with the concept of environmental protection. As circular economy is an «exotic species» to China, domestic scholars have different cognition and explanations of circular economy and its essence and connotations. This article not only summarizes and compares the theoretical research results of circular economy in China and abroad, but also focuses on the analysis of the development of the circular economy model's application in the context of China's economic development. Combined with the theory of circular economy, it is envisaged to build a sustainable development model of circular economy and promote the construction of harmony and a new understanding of social development.

In the process of rapid economic and social development in recent years, China's economy has adopted an extensive growth mode at the expense of resources and environment. Accelerating the transformation of economic growth mode and vigorously developing a circular economy is an inevitable choice for countries all over the world who seek sustainable development. It is also an important way to implement sustainable development strategies for China. How to take effective measures to promote the development of circular economy and achieve sound and rapid economic development is an important and not negligible task in taking the road of new industrialization and building a well-off society. The development of a circular economy has certain significance for China, as it will allow it to alleviate the resource and environmental «bottlenecks», solve the

resource and environmental problems, build a well-off society in sustainable way, achieve carbon peaks, carbon neutrality, and promote China's economy on the path of green and low-carbon circular development research value.

Literature Review and Problem Statement

As a brand-new development concept, economic model and industrial form, circular economy has a rich theoretical foundation and system. The study of circular economy requires comprehensive knowledge of ecology, system science, environmental science, economics and other disciplines. Learning is its foundation, and its essence is an ecological economy (Ji, 2004). As human beings pay attention to their own living environment and the urgent need to improve the quality of life, the idea of circular economy was inevitable. However, whether there is a balance between environment and development is an important indicator for judging the quality of economic development of a country or region. Promotion of sustainable development strategy is a way to find balance between the two, and circular economy is an important guarantee for achieving sustainable development. With the continuous expansion of China's economic might and the continuous growth of population, economic and social development is an increasing demand for resources and a burden on the environment. There is an urgent need to re-examine the thoughts and values on nature and development, and a new development model that can take into account economic development and ecological balance must be explored. The application of circular economy model to achieve a development vision that takes into account both economic development and ecological balance is the main idea of the research and discussion in this article.

In 1962, American biologist Rachel Carson published the book *Silent Spring*. It was the first to show the harm of pesticide pollution to people, trying to arouse human reflection on the traditional view of development. In the same year, American economist Balding put forward the concept of circular economy from the perspective of economics. He compared the earth on which humans live to a spaceship. It depends on continuously consuming its own limited resources to survive. If it is unreasonably developed, the environment will be destroyed, just as the spacecraft would be (Herman, 2001). It was precisely this circular economy idea that transformed the traditional linear growth economy (relying on resource consumption) into a closed ecological economy relying on the recycling of resources. Although this theoretical idea was advanced at the time, it quickly gained wide acceptance.

In 1972, the Club of Rome published the famous report *The Limits of Growth*, which advocated the coordinated development of economy, society, resources, environment, population and science. In the same year, Barry Com-

moner put forward the «closed cycle thinking» point of view in his book «Closing Circle». He suggested that we can reduce the pollution and destruction to the natural system by the production of material wealth only by establishing a closed loop or closed mechanism in the production technology, and at the same time following the laws of ecology (Commoner, 1971). Through the collation and comparison of the literature, we found that these points of view have enriched the connotations of circular economy in economic society.

On June 5, 1972, the United Nations Conference on the Human Environment was held in Stockholm, and the Declaration on the Human Environment was passed. The meeting stated that while developing and using nature, humans must also bear the responsibility and obligation to preserve it. The proposal of this concept has awakened the ethics of attaching importance to environmental issues, and promoted the arduous and remarkable exploration of protecting and improving the environment in various countries around the world. For example, in the 1980s European scholars took the lead in putting forward the concept of «sustainable development». In the *Our Common Future* report drafted by the World Conference on Environment and Development in 1987, the concept of «sustainable development» was first presented to the world in the form of text. For the first time, the meaning of sustainable development was explained systematically, namely «meeting the needs of contemporary people without compromising the ability of future generations to meet their own needs». In 2003, Heinz Strebek explained circular economy from the perspective of sustainable development and from the perspective of resource scarcity. He believed that the model of circular economy should be based on nature and be integrated into the ecosystem, and that its material and energy cycles are regular. He also briefly analysed the possibility and motivation of developing circular economy (Strebek, 2003).

At the turn of the century, in the 1990s, sustainable development strategy became the guiding ideology for the development of all countries in the world, and sustainable development strategy became a global trend. Major developed countries in the world began to attach importance to the practice of circular economy, and began to use legal means to restrict and implement it. At the second World Conference on Environment and Development in 1992, the participating countries around the world unanimously adopted a series of programmatic documents such as the *Rio de Janeiro Declaration on Environment and Development*, *Agenda 21* and *Declaration of Principles on Forest Issues*, as well as signed the *Framework Convention on Climate Change* and the *United Nations Convention on Biological Diversity*. We have compared a series of programmatic documents and the contents of the *Convention* and learned that the global consensus on cooperation in the field of environment and development has been strengthened, reflecting the new thinking and new consciousness of the sustainable development of today's human society.

In August 2002, the World Summit on Sustainable Development was held once again. It deepened the understanding of sustainable development of mankind. It is precisely under the influence of such a global environment that developing countries represented by China have also begun to put the development of a circular economy and the realization of sustainable development as a national strategy on the agenda. For example, in China, on April 29, 2020, the 17th meeting of the Standing Committee of the 13th National People's Congress reviewed and approved the revised Solid Waste Pollution Prevention Law, which clearly strengthened the responsibility extension system and promoted recycling of solid waste. Waste reduction, resource utilization and harmless construction, as well as the implementation of the revision of the law, has boosted the development of China's circular economy. In February 2021, the State Council of China issued the Guiding Opinions on Accelerating the Establishment and Improvement of a Green and Low-Carbon Circular Development Economic System, proposing to establish and improve a green and low-carbon circular development economic system, and promote the economy on the path of green and low-carbon circular development. This is the basic policy to solve the ecological problems of China's resources, environment, and the primary way to achieve the goal of carbon peak and carbon neutrality (State Council Fa, 2021).

However, when we explored the development and role of circular economy, we found that the current definition of circular economy in China is complicated. This is mainly seen when Chinese scholars define circular economy, as most of them borrow the basic definition of «material closed loop» from foreign countries. «Mobile economy» is a key word that pops up often, but upon further reflection, the concepts diverge due to different cognition and explanatory angles. Therefore, the analysis of the literature found that the existing definitions are mainly up to the interpretation of each scholar, the changes in their research field, and the different perspectives of thinking.

The following views are mainly representative. In the *Eleventh Five-Year Plan*, China's future is defined as «the development of a circular economy, which refers to the adherence to the development and conservation of equal importance, the priority of conservation, in accordance with the principles of reduction, reuse, and resource utilization, vigorous promotion of energy conservation, water conservation, land conservation, and resource conservation, comprehensive utilization, improvements in the recycling system of renewable resources, comprehensive promotion of clean production, and creation of a low-input, low-consumption, low-emission and high-efficiency economic growth mode».

Zhou Hongchun (2002), a researcher at the Development Research Centre of the State Council of China, believes that circular economy consists of using waste recycling to achieve economic development, in order to achieve the least input of resources in the production process, the least discharge of waste in the process of distribution and consumption, and the least harm to the environment.

He views it as an economic development model with low resource consumption, high output and low emissions.

The Research Group on the Development of Circular Economy in Shanghai (2001) believes that the circular economy is an answer to the traditional linear economy. It aims at the traditional high consumption, high emissions, and high pollution in order to improve resource utilization efficiency, protect the environment, and reduce pollution emissions. Resourcing and harmless treatment are used as means to gradually realize the sustainable development of economy, society and environment.

Jinxin Peng, Ganshun Li (2003) and others believe that the prerequisite for the realization of circular economy must be the transformation of the production processes on the basis of minimizing the pollution discharge in the whole production process and optimizing clean production and initial management. They believe in an economic growth mode that integrates a series of sustainable development concepts such as the recycling of end-of-life wastes.

Rubai Mao and others defined circular economy from the perspective of technological development. He used the theory of paradigm, according to the different social and historical conditions, the prerequisites of technological development and economic development, and the different understanding and perception of environmental issues of the operating mechanism to explore two different paradigms, namely the end governance paradigm of the production process, and the circular paradigm of overall economic operation (Mao & Feng, 2003).

Qu Geping (2002) defines circular economy from the perspective of the relationship between man and nature. He believes that the essence of circular economy is a closed-loop flow economy, which integrates clean production and comprehensive waste utilization. It requires the flow of materials, information, and energy. The operation law of the flow itself re-plans and designs the system, and realizes the full closure of the system through the introduction of closed loops, minimizes the input of resources and the output of pollutants, and establishes a new type of economic growth mode.

Zhang Kai (2004) defines circular economy from the perspective of economic morphology. He believes that circular economy is based on ecology and that it must follow the principles of ecology and economics to reduce, reuse, and recycle. IN his opinion, it requires the system method to realize the closed-loop flow mode of material and energy in the production process, so that the traditional end-of-production emissions are transformed into reused resources for production, and the pressure on the ecosystem of excessive exploitation of resources and excessive pollution discharge is alleviated. On the premise of protecting the environment, the ecologicalization of economic activities is realized by improving the efficiency of resource utilization, environmental benefits and the quality of economic development, and the win-win of economic, social and environmental benefits can be achieved.

Dajian Zhu believes that circular economy plays a role in organizing economic activities, that is, according to the process of resources, products, and renewable resources, it feeds back the process of economic production. This effect makes all resources adequate and reasonable. At the same time, it can be used cyclically and endlessly, which can reduce the damage to nature and at the same time better develop the economy (Zhu & Zhu, 2003).

Li Ruxiong (2004) believes that the greatest benefit of circular economy lies in obtaining resources needed for economic redevelopment. Most of them can be obtained through recycling or regeneration. Recycling and regeneration of products after use can reduce waste and pollution and create raw material for further production.

Ma Kai (2004), then director of the National Development and Reform Commission of China expressed his views on circular economy in the article *Implementing the Scientific Outlook on Development and Vigorously Promoting the Development of Circular Economy*. He stated that circular economy is a kind of efficient use and recycling of resources, with the basic characteristics of «low consumption, low emissions, and high efficiency», an economic growth model conforming to the concept of sustainable development, as opposed to the foundation of the traditional growth model of «mass production, mass consumption, and mass abandonment». According to relevant data analysis, this definition in China is by far the closest to the essence of circular economy and the most acceptable concept to all parties.

Therefore, the aim of this article is to generalize the existing practices of circular economy in China and determine the effectiveness of the current model and prospective directions for its development.

Research Results

Application and practice of circular economy model in China

Due to the late start of industrial development, China has caused serious industrial pollution in the process of rapid economic development. In order to take into account the relationship between economy, resources and environment, we are exploring and practicing a circular economy development path that suits our own national conditions in industrial development. To this end, this article summarizes China's behaviour in the practice of circular economy, which can be roughly divided into several stages.

Resolution stage (1971-1979)

In the process of China's early industrialization, environmental pollution caused by linear economy gradually became prominent. In April 1971, the former Military Control Commission of the Ministry of Health issued the Notice on the Investigation of the Degree of Water and Air Pollution Caused by the «Three Wastes» of Industry to the Health Bureau of the Revolutionary Committee of the provinces (autonomous regions and municipalities). This document was the first national document issued by the central government to solve the industrial «three wastes» problem. The document required all localities to conduct a comprehensive survey of major factories and mines in their jurisdictions to understand the pollution discharge situation, discharge system, recycling methods, and impact on the health of surrounding residents and other industries (Hongtao, 2016). China's use of the «three wastes» of industry at that time was a manifestation of the use of waste at the end of a circular economy.

Initial development stage (1980-2003)

From the 1980s to the beginning of the 21st century, China accelerated the process of industrialization in order to improve its economy and productivity, causing increasingly serious environmental pollution problems. At this time, from the initial end-of-line waste recycling and management, to the reduction of resource use and the comprehensive management of intermediate production links, the development of an economic ecosystem has become an important means of solving environmental problems. In the 1980s, China's circular economy laws and regulations made breakthroughs. The issued laws and regulations were mainly relevant to the pollution of the air and water environment, and the basics of promoting the development of circular economy were stipulated. In the early 1990s, China began to publicize and promote cleaner production, and regarded it as an effective measure of developing a circular economy. After countries around the world reached a consensus on sustainable development at the United Nations Conference on Environment and Development in June 1992, China has also actively explored ways to promote sustainable development, looking for a circular economy development model suitable for China. In 1999, as a national policy, circular economy was promoted by the former State Environmental Protection Administration of China.

Exploring and refining stage (2004-2012)

Since the beginning of the 21st century, due to the over-exploitation of resources and the processing and manufacturing of materials and fuels, the total global greenhouse gas emissions have increased, industrial pollution has become serious, and the shortage of water resources has become increasingly prominent. China controls and solves industrial pollution problems and conducts comprehensive improvement of the regional environment by promoting cleaner production and building an ecological industrial chain between enterprises. At the National Circular Economy Work Conference held in 2004, the National Devel-

opment and Reform Commission put forward the development of circular economy as the guiding principle for the country to formulate the *Eleventh Five-Year Plan*.

In 2005, the development of circular economy was elevated to the level of national strategy. The State Council issued *Several Opinions on Accelerating the Development of Circular Economy* (State Council Fa, 2018), which put forward the goal of building a large number of typical enterprises that meet the requirements of circular economy development. Additionally, the first batch of demonstration pilots of the circular economy was carried out. The *Eleventh Five-Year Plan* of 2006 promoted various pilot projects of circular economy on a large scale, and summarized and refined 60 typical cases of circular economy models that could be replicated and promoted. The Recycling Economy Promotion Law promulgated in 2008 and implemented in 2009 is the main law for promoting the development of circular economy in China, and an important sign that the development of circular economy in China has embarked on the road of legalization and standardization. China's circular economy legal system has been initially established in 2013 with the *Circular Economy Development Strategy and Immediate Action Plan* issued by the State Council. It was China's first national-level special plan in the field of circular economy.

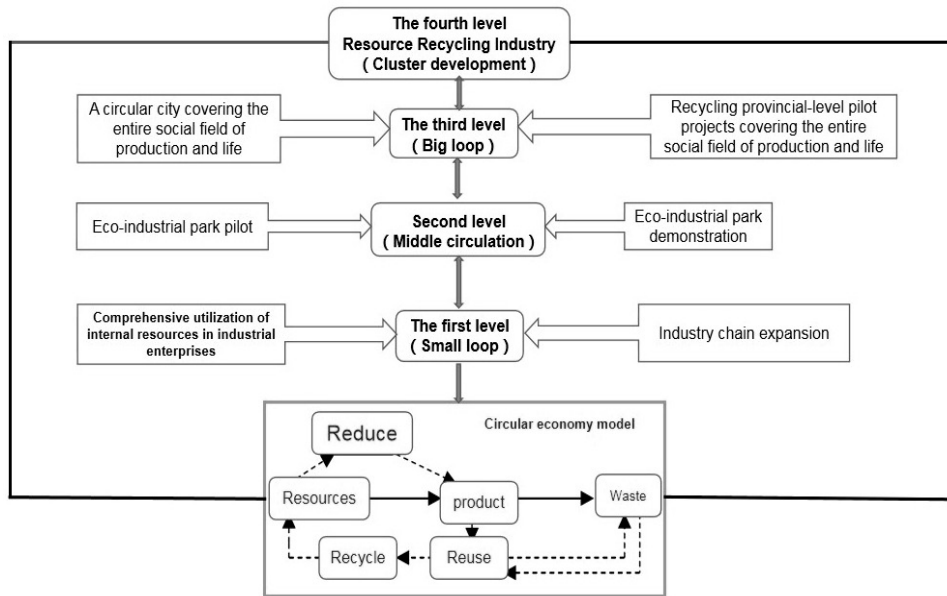
Under China's national circular economy pilot, China has explored four levels of development models, namely, comprehensive utilization of internal resources in industrial enterprises and expansion of industrial chains (small cycles), pilot and demonstration of eco-industrial parks (medium cycles), covering production and life recycling cities and provincial pilots (large recycling) in the entire social field, as well as resource regeneration industries (also called the fourth industry or vein industry) (as shown in Figure 1).

Upgrade and evolution stage (2013-2017)

The 18th National Congress of the Communist Party of China raised the construction of ecological civilization to a new strategic height, and regarded «the initial establishment of a resource recycling system» as one of the goals of building a well-off society in an all-encompassing way. During this period, the circular economy has made great progress. In 2013, the State Council promulgated the *Circular Economy Development Strategy and Short-Term Action Plan*. While affirming that the circular economy is a major strategic decision in China, it also presented a strategic plan for the development of a circular economy to accelerate the creation of an ecological civilization. Since 2013, 7 ministries and commissions including the National Development and Reform Commission have carried out the approval and evaluation of circular economy pilots. According to the report of the National Bureau of Statistics, based on 2005, China's circular economy development index reached 137.6 in 2013, an average increase of 4 points per year, and the development of circular economy has achieved remarkable results, including three major ones.

Figure 1

China's four-level development model of circular economy



China's four-level development model of circular economy

First, the reduction of resource consumption is advancing steadily. In 2013, China's resource consumption intensity index was 134.7, an increase of 34.7 points over 2005, meaning an average annual increase of 3.8 points. Compared with 2005, 4 of the 5 resource consumption indicators dropped significantly: water consumption per unit of GDP decreased by 49.1%, biomass resource consumption per unit of GDP decreased by 37.5%, energy consumption per unit of GDP decreased by 26.4%, and non-metallic consumption per unit of GDP decreased 17.4%. However, metal consumption per unit of GDP rose by 13.2% (refer to Table 1 and Figure 2 for details of indicator data changes).

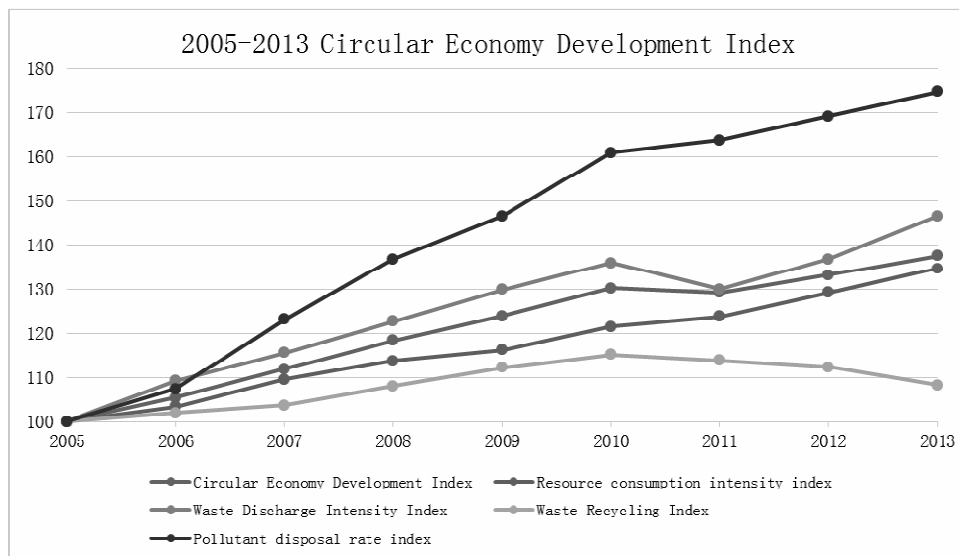
The effect of waste reduction is obvious. In 2013, China's waste emission intensity index was 146.5, an average annual increase of 4.9 points. Due to the substantial increase in industrial solid waste and other emissions, the waste emission intensity index in 2011 dropped by 6 points compared with 2010, but it rebounded significantly in 2012 and 2013. Compared with 2005, the main pollutant discharge and wastewater discharge per unit GDP decreased significantly in 2013.

Table 1

Circular Economy Development Index in 2005-2013

Year	Circular economy development index	Resource consumption intensity index	Waste discharge intensity index	Waste recycling index	Pollutant disposal rate index
2005	100.0	100.0	100.0	100.0	100.0
2006	105.4	103.4	109.2	102.0	107.4
2007	111.9	109.5	115.6	103.7	123.2
2008	118.5	113.8	122.7	108.0	136.8
2009	123.9	116.3	129.9	112.2	146.5
2010	130.2	121.6	136.0	115.2	160.9
2011	129.2	123.8	130.0	113.9	163.7
2012	133.2	129.2	136.8	112.3	169.1
2013	137.6	134.7	146.5	108.2	174.6

Figure 2

Circular Economy Development Index in 2005-2013

In particular, the chemical oxygen discharge of industrial wastewater per unit GDP dropped by 60.3%, and the ammonia nitrogen discharge per unit GDP of industrial wastewater dropped by 48.6%. The industrial sulphur dioxide emissions fell by 62.8%, and the wastewater emissions per unit of GDP fell by 38.5%. However, the volume of solid waste generated per unit of industrial added value rose instead of falling, up 10.7% from 2005 (refer to Table 1 and Figure 2 for details of indicator data changes).

The level of pollutant disposal has greatly improved. In 2013, China's pollutant disposal index was 174.6, and the index increased year by year, with an average annual increase of 7.2 points, the largest increase among the four sub-indexes. Compared with 2005, all indicators of the pollutant disposal rate in 2013 were significantly improved. In particular, the rate of urban sewage treatment increased by 37.3%, the rate of harmless treatment of municipal solid waste increased by 37.6, the removal rate of ammonia nitrogen in industrial wastewater increased by 34.4%, and the removal rate of industrial sulphur dioxide increased by 37.5% (refer to Table 1 and Figure 2 for details of indicator data changes).

The progress of waste recycling is slow. In 2013, China's waste recycling rate index was 108.2, the smallest increase among the four sub-indexes. Since 2011, the index has declined continuously, mainly due to the decline in the recycling rate of scrap resources such as steel scrap. Among the various indicators, there have been both increases and decreases compared with 2005. For example, the energy recovery rate has increased by 0.5%, the industrial water reuse rate has increased by 4.4%, the comprehensive utilization rate of industrial solid waste has increased by 5.5%, and the total utilization rate of industrial solid waste has increased by 5.5%. However, the scrap steel recycling rate fell by 6.6%, the scrap copper recycling rate fell by 8.2%, and the scrap aluminium recycling rate fell by 0.9% (refer to Table 1 and Figure 2 for details of indicator data changes).

Comprehensive index system of circular economy evaluation

The comprehensive index system of circular economy evaluation includes 4 first-level indicators, namely resource consumption intensity, waste discharge intensity, waste recycling rate, and pollutant disposal rate. There are 16 second-level indicators. Among them, resource consumption intensity includes five secondary indicators: energy consumption per unit GDP, metal consumption, non-metal consumption, biomass resource consumption, and water consumption. Waste discharge intensity includes wastewater discharge per unit GDP, solid waste generation per unit of industrial added value, per capita municipal solid waste removal and transportation volume, and two other secondary indicators. Waste recycling rate includes energy recycling rate, industrial water recycling rate, waste resource recycling rate and industrial solid waste comprehensive utilization. The rate of pollutant disposal includes the rate of urban sewage treatment, the rate of harmless treatment of municipal solid waste, and the removal rate of major pollutants.

The comprehensive evaluation of the circular economy adopts the index evaluation method, taking the index value in 2005 as the standard value, and synthesizing the circular economy development index by weighting.

The data on gross domestic product (GDP), industrial added value and urban population come from the China Statistical Yearbook, in which GDP and industrial added value are both at constant prices in 2005. The data on energy consumption and recycling rate comes from the energy statistics and accounting data of the National Bureau of Statistics. Data on water consumption, wastewater discharge, industrial solid waste generation, municipal solid waste removal, main pollutant discharge, urban sewage treatment rate, harmless treatment rate of municipal solid waste, and recycling rate of industrial water are taken from China Environmental Statistics Yearbook. Metal consumption, non-metal consumption, biomass resource consumption, main pollutant removal rate, comprehensive utilization rate of industrial solid waste, waste resource recycling rate, etc. are based on China Statistical Yearbook, China Environmental Statistics Yearbook, National Bureau of Statistics, Nonferrous Metals Statistics of associations, building materials associations, iron and steel associations and customs.

According to the statistics of relevant Chinese industry associations, in 2014, the output value of China's resource recycling industry reached 1.5 trillion yuan, with 20 million employees, and nearly 250 million tons of various wastes and renewable resources recovered and recycled. Nearly 200 million tons of standard coal were saved, wastewater discharge was reduced by 9 billion tons, and solid waste discharge was reduced by 1.15 billion tons. From 2005 to 2014, China used a total of 2.04 billion tons of industrial solid waste, 790 million tons of scrap steel, 80.85 million tons of recycled copper, recycled aluminium, recycled lead, and recycled zinc, 80.85 million tons of recycled non-ferrous metals, 188 million tons of waste plastics, and 6.03 tons of waste paper. In the first four years of the *Twelfth Five-Year Plan*, China's resource output rate increased by about 10%, energy consumption per unit of GDP fell by 13.4%, and water consumption per unit of industrial added value fell by 24%. In 2016, the National Development and Reform Commission and the Ministry of Finance issued the Notice on Printing and Distributing the Typical Experiences of National Circular Economy Pilot Demonstration to promote a group of typical experiences and practices of circular economy throughout the country, promote the comprehensive and in-depth development of circular economy, and advance the level of ecological civilization. To this end, the development of circular economy has played an important role in alleviating resource constraints, protecting the ecological environment, adjusting industrial structure, promoting economic growth, steadily expanding employment, promoting green transformation and development, and building ecological civilization, and has achieved significant economic, environmental and social benefits.

Deepening the promotion stage (2018—)

In order to deepen the reform of comprehensive solid waste management, the Ministry of Ecology and Environment took the lead and worked with 18 de-

partments and units to compile and complete the *Working Plan for the Pilot Project of «Waste-Free City» Construction* (hereinafter referred to as the Plan). The Plan puts forward the management concept of a «waste-free city», aiming to achieve the goal of minimizing the amount of solid waste generated in the entire city, fully utilizing resources, and ensuring safe disposal (State Council Fa, 2018). The construction of a «waste-free city» is guided by the new development concept. By promoting the formation of green development methods and lifestyles, China aims to continue the promotion of resource reduction, resource utilization and safe disposal of solid waste, so as to realize the sustainable management of all resources and energy. The proposal of the «waste-free city: pilot program marks the advanced stage of China's circular economy development (Cheng, 2019).

Having analysed the practices and attitudes to circular economy in China through the years, we can conclude that the application of circular economy is gradually moving from a small cycle to a large cross-industry cycle, from the cycle of a single product to the integrated cycle of the park. Moreover, the establishment of a dynamic three-dimensional circular economy system has ensured that the circular economy can further enhance China's ability to cope with resource constraints, provide environmental protection, and adjust the industrial structure to avoid bottlenecks. Therefore, it can be said that the circular economy can be applied and promoted in China and will have a lasting impact.

In view of the existing data, it is obvious that in 2020, China's resource output rate will increase by 15% compared with 2015, while the waste recycling rate will be around 55%. From this, we can conclude that China's environmental governance has gradually progressed, which will further promote the rapid development of circular economy. Several key recycling policies of China are outlined in Table 2.

It is also worth noting that the recycling industry has gradually become a new growth point for China's economic development, achieving better environmental and economic benefits. According to data from the National Bureau of Statistics of China, the New Momentum Index of China's economic development in 2018 increased by 28.7% over the previous year. The development of the circular economy has achieved remarkable results. As of the end of 2017, China's non-ferrous metals waste, waste steel, waste paper, waste batteries, waste tires, waste textiles, waste electrical and electronic products, waste glass, waste plastics, and scrapped motor vehicles have been recycled in ten categories. The total amount of resource recovery reached 282 million tons, an increase of 11% year-on-year. In particular, in terms of the types of recycling, scrap iron and steel and waste non-ferrous metals are the main categories, accounting for nearly 70% of the total recycled resources. At present, China's resource recycling channels are relatively scattered, the nature of the industry is relatively specialized, and the market integration of leading companies is not high. In terms of geographical distribution, China's recycling companies are mainly located in East China, South

China and North China. As China's policies continue to be favourable and enterprises are strengthening resource recycling, the size of China's recycling market continues to grow. By 2020, the industrial output value will reach nearly 3 trillion yuan. Figure 3 details the recovery value of China's main recycled resource categories.

Table 2

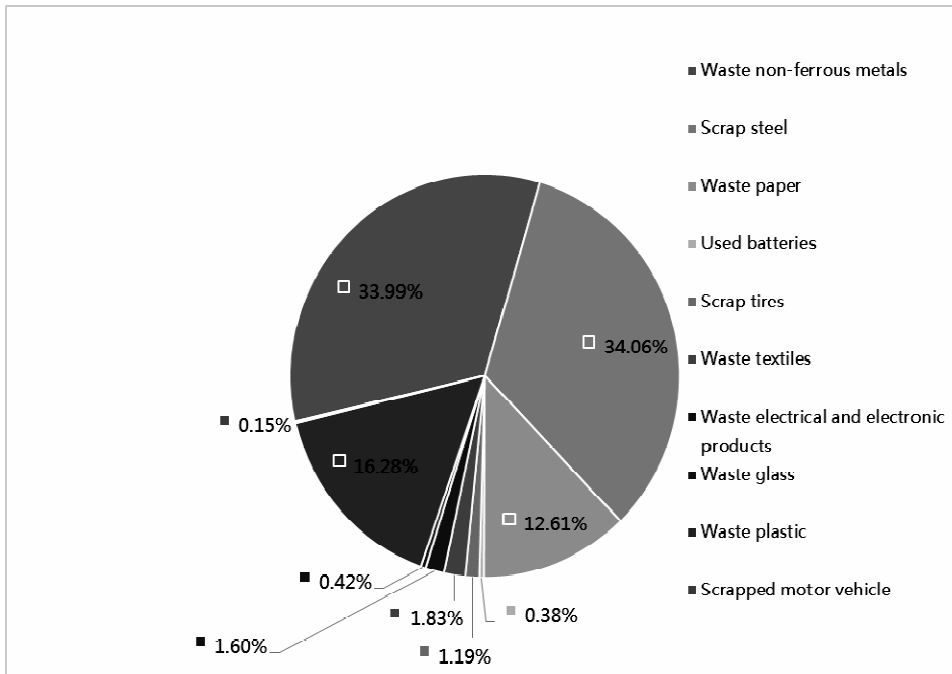
Policies related to resource recycling in China

Adoption date	Policy name	Brief outline
May 2017	Circular Development Leads Action	By 2020, the output rate of major resources will increase by 15% over 2015, and the recycling rate of major waste will reach 54.6%. The comprehensive utilization rate of general industrial solid waste will reach 73%, the comprehensive utilization rate of crop straw will reach 85%, and the industrial output value of resource recycling will amount to 3 trillion yuan. 75% of the national parks and 50% of the provincial parks will have carried out circular transformation.
November 2017	Guiding Opinions on Promoting the Construction of Asset Recycling Utilization Bases	Speeding up construction of resource recycling facilities (in particular for scrap iron and steel, waste non-ferrous metals, waste tires, construction waste, food and kitchen waste, garden waste, waste textiles, waste plastics, waste lubricants, waste paper, express delivery). Construction of places where urban waste such as packaging, waste glass, domestic garbage, and urban sludge are classified for utilization and centralized disposal. Promotion of garbage classification and resource recycling, facilitation of development of new cities.
May 2018	Notice on Promoting the Construction of Resource Recycling Bases	Facilities registered by the two ministries and commissions can enjoy corresponding policy support and financial subsidies.

Source: Compilation of public data.

Figure 3

Recycling value of China's main categories of recycled resources



Source: China Industry Information Network.

With the rapid development of recycled resources, innovative recycling models continue to emerge, and building a recycling industrial system is an important measure to promote recycling. This requires a fundamental change to China's circular economy from the traditional and extensive development mode of mass production, mass consumption and mass abandonment. It is an important guarantee for the sustainable use of resources and strategic security of China's resources. This will prevent environmental pollution at the root of the problem and ensure its effective resolution. An effective approach to environmental risks means an inevitable choice to promote green transformation and development, building an ecological civilization, and realizing the goal of building a well-off society in an all-encompassing way, thus achieving the Chinese dream of the great rejuvenation of the Chinese nation.

Prospective directions of development of the Chinese circular economy

In recent years, with the orderly development of China's domestic eco-industrial parks, environmental protection industrial parks, and circular economy demonstration pilots, China has achieved remarkable results in the development of circular economy. However, China's circular economy has not been well promoted in establishing a sound green and low-carbon circular development economic system. Moreover, the active development of renewable energy and vigorous promotion of energy-saving and emission reduction technologies are the embodiment of the supporting role of science and technology in the development of circular economy.

The analysis of the dominant opinions on circular economy among Chinese scholars and the current achievements of circular economy in the country leads this paper to make several recommendations on the development of China's circular economy in the future. Namely, it needs to be strengthened through the development of education and awareness of circular economy among the public, the establishment and improvement of public participation platforms, and the promotion of green consumption. Several areas are still suffering from drawbacks, either economic or social in nature, to improve which we believe that a range of measures outlined below should be implemented and facilitated.

Introduction of innovations top-down and capacity to expand

The rational use of circular economy is an exploratory and innovative work in economic and social development. There is no precedent to follow. This requires the government to strengthen the top-level management design and innovatively formulate governance measures in their early stages. Ensuring a proper operation of any system requires a set of oversight and assessment tools. According to the new requirements of the current stage of development, the various indicator systems must be appropriately improved.

The ability to support the expansion of circular economy by technology and capital needs to be strengthened. The original intention of circular economy is to solve the problems of environmental pollution and resource shortage in the process of social development. However, in practice, if a company internalizes environmental and resource costs in accordance with the concept of circular economy, production costs will obviously be directly reflected in the price, which will eventually cause the products to lose price competitiveness and the company will experience a «thrombus» phenomenon. First of all, this will make it difficult for companies to choose between the cost of transformation and their own interests. Second, if the state wants to achieve scientific and technological innovation in a circular economy, companies need a large amount of capital investment. Due to

capital shortages, some companies have outdated production equipment and technology. There are also certain differences in production and operation standards, resulting in high energy consumption and high pollution industries. The capacity for technological innovation is not strong, and the utilization rate of resources in production links is low. Third, in the recycling process of enterprises, at present, the cost of pollutant treatment equipment is generally high, the degree of waste recycling is not, and the development of technological updates for processing various types waste is lagging. In certain situations, the cost of recycling waste into useful resources is 20% higher than the cost of purchasing new resources, which is not conducive to promoting circular economy.

It is clear that advancement must be made in these fields to facilitate the promotion of circular economy. The relevant departments must be responsible for publishing development on technology related to circular economy. Process and equipment catalogues should be encouraged by the state, and there must be guaranteed budgetary funds to support a batch of typical technology promotion and application. The scientific and technological departments should coordinate to establish major scientific research projects. At the same time, it is necessary to further improve the training and introduction mechanism of innovative talents, who can use innovation to drive the optimization and upgrading of the industrial structure and extend the industrial chain for the efficient use of resources and the improvement of the level of green development.

Integration of circular economy management between government, enterprises and the public

The successful implementation of the changes in the previous area requires participation at all levels. Thus, the multi-dimensional co-governance operating system connecting the authorities, enterprises and the public needs to be improved. In pursuit of quick maximization of benefits, some local governments in China have ignored the long-term benefits of circular economy, thus promotion of harmonious social and economic development, industrial guidance and supporting policies are lacking. Some enterprises pay relatively little attention to the development of circular economy, especially in the field of heavy industry, where the phenomenon of extensive operation and production still exists. In addition, the public has not yet fully understood their role in the circular economy, thinking that it is a matter of the government and enterprises, and their own participation has little effect, so there is low awareness of environmental protection measures. It is clear that the lack of coordination between management of circular economy by the government, enterprises and the public has led to several negative consequences. The government's role in guiding enterprises is minimal and the public does little to guide and operate the norms of circular economy. Moreover, enterprises lack financial and technical support for circular economy policies and the public's attitude to circular economy policies results in poor institutional supervision.

In this process, the status, responsibilities and relationships of the government, enterprises, and the public must be clarified. It is clear that the government is the macro-controller for the development of circular economy and should provide supervision, regulation and guidance. It should take the lead in formulating a circular economy reward and punishment assessment system, strengthen supervision and law enforcement, and formulate related supporting measures to play a corresponding guiding role. Relevant responsible departments should coordinate to deal with specific implementation problems and provide backing for the development of circular economy. At the same time, economic incentives such as taxation, finance and prices should be used to support circular economy projects and industries.

Enterprises are the main drivers and actors of the development of circular economy. In the development process, both their own economic interests must be considered, and the corporate social responsibility must be brought into play. It must be ensured that the company implements the concept of circular economy throughout production, through the practice of green production methods, increased clean productivity, better management of the whole production process, extended producer responsibility system, and strengthened disclosure of corporate environmental information.

The public is the foundation for the development of a circular economy. To improve the national action system for circular economy, public supervision and reporting and feedback mechanisms must be improved, citizens' environmental literacy must be raised. They should be encouraged to actively carry out garbage classification, practice green lifestyles, green travel and green consumption. Only the concerted efforts of the government, enterprises, and the public can promote the transformation of the city from waste production and utilization to less waste and no waste, and finally realize the beautiful vision of the circular economy effect of a «waste-free city» (Cheng, 2019).

Public awareness and incentives for business

The circular economy is a subversion of the past management model and production method, so enterprises and the public have no experience to follow. In the process of circular economy development, the leading role should be given to pilot demonstrations to ensure dissemination of knowledge on a large scale. Additionally, building on the first batch of pilot projects to create «no-waste communities», «no-waste parks», «no-waste villages», and other multi-dimensional circular economy constructs will lay a solid foundation for the final establishment of a high-quality circular economy.

From practical point of view, several aspects should be excessively promoted. The state should vigorously encourage the development of green design, selection of durable, easily degradable, and low-polluting raw materials, improvements in the recyclability of products, and add green labels to recyclable products. The management of the whole life cycle of waste can be conducted

according to green labels. The government has set up special funds to encourage communities, supermarkets, hotels, restaurants and other public places to jointly establish a green points system. This system can be expanded to introduce «rewards» in exchange for green points. Moreover, the citizens' awareness of green consumption must be raised. Vigorous popularization of green product labelling and increase in the penetration rate of green products are key. The public should be encouraged to use separate collection containers for waste recycling. The education of citizens on recycling and green practices must be expanded to this end.

There must be an established working mechanism for the construction of a «waste-free city» as the starting point of pushing circular economy into an advanced stage of development. The social capital access system must be adopted to set up special funds for the construction of «waste-free cities» and to subsidize the recycling industry market. National financial special funds and government investments should be used directly to drive the market. Finally, the experience of the «waste-free city» pilot project should be actively promoted in various parts of the country, along with the advanced technologies and models of the pilot enterprises, pilot provinces and cities connected to the concept. The path towards «waste-free society» should be explored in the context of developing circular economy.

Regulatory support of circular economy

The supporting laws and regulations to promote the sound development of circular economy still need to be improved. At present, although China's circular economy legal framework has been established in broad terms, it has not yet become a complete system. The supporting laws and regulations are not yet complete, and the special legislation is not all encompassing. Most laws and regulations still largely focus on the protection of environmental resources, simply stipulating the promotion of the development of circular economy, but there is a lack of coordination between the two notions. For example, the Circular Economy Promotion Law, which was adopted in 2009, has established principles and regulations in many aspects, but it lacks certain operability in guiding and regulating producers. In addition, the circular economy laws and regulations are still stuck in terms of reducing resource consumption, clean manufacturing of products and waste treatment. The circular economy involves many technical standards, specifications and requirements, and in this regard China still has room for improvement in the necessary mandatory standards and other technical specifications.

First, at the legislative level, the sustainable production, consumption, and waste treatment practices should be legally enshrined, and at the same time, incentives for recycling and ethical consumption should be strengthened. Second, specific industry guidelines, such as waste collection, hazardous waste transportation and trading, social waste sorting and recycling, as well as bulk industrial solid waste treatment mechanisms and operating modes all require clearer regulations or authorizations. Third, there is need to improve and perfect the standard

system, and formulate product technical standards for industrial by-products and comprehensive resource utilization products by category. Finally, the responsibility for ensuring the implementation of circular economy must be established in terms of producers, consumers, and regulators.

Conclusions

Starting from the basic theory of circular economy, this article summarizes the application and development of circular economy in China and the shortcomings encountered in the process based on the connotations of circular economy, discusses the current situation in China and suggests possible avenues for further development of the system in China.

It is found that there is no unified interpretation of «circular economy» among the Chinese scientists, however, the common connotations concern the introduction of environmentally-friendly practices into industry operations to ensure the balance between economic development and nature preservation. This outlook has evolved since the first introduction of the term in 1970s and reflects the global advancements in this field over the last fifty years.

As China started the industrialization processes comparatively late, they were characterized by high intensity, which in turn led to a quickly accumulating environmental burden. This prompted the Chinese authorities to consider the progressive notion of circular economy as early as 1970s, which was first realized through promotion of public awareness, and later enshrined in strategic development documents. China has consistently paid substantial attention to the development of circular economy and made significant strides by the start of the new millennium. China's four-level development model of circular economy has proved to be effective, as can be seen from the Circular Economy Development Index. A comprehensive analysis of the two-level system of indexes shows considerable improvements in most categories from 2005 to 2013, with waste recycling being the slowest area.

Having analysed the practices and attitudes to circular economy in China through the years, we can conclude that the application of circular economy is gradually moving from a small cycle to a large cross-industry cycle, from the cycle of a single product to the integrated cycle of the park. Moreover, the establishment of a dynamic three-dimensional circular economy system has ensured that the circular economy can further enhance China's ability to cope with resource constraints, provide environmental protection, and adjust the industrial structure to avoid bottlenecks. It is also worth noting that the recycling industry has gradually become a new growth point for China's economic development, achieving better environmental and economic benefits.

China has achieved remarkable results in the development of circular economy. However, there are still several avenues for improvement, which the country can pursue in the future. In particular, China's model of circular economy can be strengthened by introducing innovations top-down and ensuring the capacity to expand circular economy practices at all levels of state – enterprise – the public system. To that end, public awareness must be raised and further incentives for enterprises must be established to ensure the advent of «waste-free society» and realization of China's goal of building a well-off society in an all-encompassing way. Finally, the legislative support of circular economy should be improved and deepened to eliminate «blind spots» in oversight, guidance and promotion of circular economy practices.

References

- Cheng, H. (2019). The construction of a «waste-free city» is an advanced stage of the development of circular economy. *Environmental Economics*, 5, 40-43.
- Commoner, B. (1971). *The closing circle: Nature, man, and technology*. Knopf.
- Geping, Q. (2002). The development of circular economy is a general trend in the second century [in Chinese]. *Contemporary Ecological Agriculture*, 12, 18-20.
- Herman, E. D. (2001). Cherish the earth-economics, ecology, ethics [in Chinese]. The Commercial Press.
- Hongchun, Zh. (2002). Discussion on the economic feasibility of rural social endowment insurance system [in Chinese]. *Journal of Capital University of Economics and Business*, 2, 11-15.
- Hongtao, L. (2016). *Environmental pollution investigation in the 1970s and the start of China's environmental protection* [in Chinese]. <http://www.h2o-china.com/news/243866.html>
- Ji, K. (2004). *Principles and applications of circular economy* [in Chinese]. Anhui Science and Technology Press.
- Kai, M. (2004). Implement and implement the scientific development concept, vigorously promote the development of circular economy [in Chinese]. *China Economic and Trade Guide*, 19, 4-8.
- Kai, Zh. (2004). Rethinking the theory of circular economy [in Chinese]. *China Population, Resources and Environment*, 6, 48-52.
- Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste of April 29, 2002 [in Chinese]. http://www.mee.gov.cn/ywgz/fgbz/fl/202004/t20200430_777580.shtml

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- Mao, R., & Feng, Zh. (2003). *On circular economy* [in Chinese]. Economic Science Press.
- Peng, J., & Li, G. (2003). *Reducing the environmental load and regulation of policies and regulations: China's environmental protection theory and practice* [in Chinese]. China Environmental Science Press.
- Peng, L. (2008). *Research on the development model of new industrialized cities based on circular economy* [Unpublished doctoral dissertation]. Xiamen University.
- Ruxiong, L. (2004). Recognize the new forms of reform and development to promote the harmonious development of man and nature [in Chinese]. *Research in Science of Science*, 1, 1-6.
- Shanghai Development of Circular Economy Research Group. (2001). Shanghai Development of Circular Economy Research [in Chinese]. *Macroeconomic Research*, 8, 2-6.
- State Council Fa. (2021). *Guiding opinions of the State Council on accelerating the establishment and improvement of a green and low-carbon circular development economic system* [in Chinese]. China Government Network. http://www.gov.cn/zhengce/content/2021-02/22/content_5588274.htm
- State Council Fa. (2018). «Waste-free city» construction pilot program [in Chinese]. http://www.gov.cn/zhengce/content/2019-01/21/content_5359620.htm
- Strebel, H. (2003). *Industrial recycling networks as an entrance into circular economy*. Paper presented at the Programme and Conference Proceedings of the Summer Academy on Technology Studies.
- Zhu, D., & Zhu, Y. (2003). In-depth understanding of circular economy from the perspective of ecological efficiency [in Chinese]. *Productivity Research*, 6, 123-125.

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