New Recycle Economic Theory Direct Technology Innovation and the Sustainable Development of Beijing

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Abstract

The recycle economy is the first stage of knowledge economy. In March 2005, the author attended the forum of "Festival of Thinkers" in the capital of United Arab Emirates, Abu Dhabi. Through five days" discussing with 10 Nobel Prize winners and 18 thinkers from five continents, the conception of Recycle Economy is regulated. The former principle of "3R" in clean production has been expanded to "5R" in new recycle economy, adding concept of "rethink" and "repair" to the "reduce, reuse and recycle". This article makes a full exposition to the origin, contents and its innovation to the classical western economics of the new recycle economics. Before the 2008 Beijing Olympics, the article discusses the application of new recycle economy in terms of promoting the ability of national innovation system and independent innovation, city construction and the industry innovation concerning Beijing's features.

Keywords: new recycle economics, 5R, innovation, 2008 Beijing Olympics

Introduction

If any country or city could become an innovative type one, its target is to realize a sustainable development of society in harmony with human beings and nature. In 2005, the GDP of China was 2.235 trillion dollars, and China has exceeded the U.K. to become the fourth economic entity in the world. For continuously and stably developing the Chinese economy, and becoming an innovative type country, both theory and technological innovation are needed for the country or for a city. The rest of the paper is organized as follows. Section 1 analyzes the economic achievements in China. Section 2 introduces the "5R" concept of the new recycle economics. Section 3 discusses how this

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new concept directs the preparation of 2008 Beijing Olympics and the sustainable development of Beijing.

Ⅰ. Analysis of the Economic Achievements in China

How could China achieve such a miracle? The analysis for the reasons and the comprehension for the different viewpoints in western economics are the base for the new recycle economics in China.

- The reform: the unprecedented liberation of labor in large quantities and at low wages.

Since the late 1970s, millions of individuals who had been restricted for 2000 years become available for cheap labor; this has propelled the unparalleled force of the Chinese miracle.

How can China maintain the past century's rate of progress and how can China continue this prosperity into the future, are two of the most pressing questions warranting research by Chinese academics. How to maintain the ecosystem and balance economic development in a harmonious manner are the most important aspects for society, as well as the fundamental tenets of the innovation of economics in China.

- The opening: the sufficient use of two types of resources and markets.

Under the trend of integration into a world economy, China has not only utilized its abundant natural resources and large national market sufficiently, but it has also employed the resources and product markets of the world. The scale of production and of resources has exceeded that of the industrialization in both England and America. The use of these resources and markets are the strong basis for the rapid development in China.

At the same time, how to continue the past century's successful utilization of the two resources and markets into a sustainable future is a key question facing the economy of China. The recycling of

resources and the improvement of technology are the most important contents for the problem, and also the primary part of the innovation of economics in China.

- High saving's ratio and large investment from both domestic and international sources.

During the reform and opening of China, increase of the saving's ratio has accelerated the domestic investment, which combined with the growing enormous foreign investment, have played an important role to the acceleration of the economic development. According to statistics, the average gross domestic saving's ratio of China in last century was 40% of GDP. This number has risen to 46% in 2005, the highest in the world. The average saving's ratio of the U.S. at the highest level of history was only about 16%, and Japan had ever reached up to 30%, but never exceeded 40%. The high national saving's ratio has supported the continuous growing of the Chinese economy, and the elasticity coefficient between the growth rate of savings and that of GDP kept between 1.9%—2%, namely, when GDP increased 1 dollar, and the savings increased 2 dollars.

The continuing investment from Chinese and foreigners has been an important capital force for rapid growth in China. The quantity exceeds that of foreign investment in England and America at the time of their industrial revolution.

How to continuously attract investment, improve its fundamental structure, and form a positive cycle is a key aspect in the research and innovation of China's economy.

- The socialistic market economic policy to "explore one's way carefully."

The base policy to "explore one's way carefully" was established through the abandonment of the so-called planned economics of the Soviet Union and through broad utilization of different schools of western economic thinking. The policy acts to settle the successful socialistic economic policy and lead to the sustainable and rapid growth of China's economy in a free economy.

China has achieved enormous achievements and received tremendous accolades from international economists, and the above factors illustrate the conditions and necessity to create a new economics in China, which can direct the sustainable development of China in the future.

Ⅱ. "5R" Concept in New Recycle Economics

With the principle of "reduce, reuse and recycle", in the large system of human being, natural resource and science & technology, and taking consideration of the capacity of nature resource, the recycle economy transits from traditional linear and unidirectional growth mode of "resource – product – waste", which is characterized by "mass-produce, mass-discharge and mass-disuse", to the feedback and cycling type of "low-consumption, low-discharge and high efficiency". In this new mode, the "waste" also takes part into the ecological cycle of physical matters, and reaches a harmonious state with them. The recycle economy, which avoids the negative the impact on the natural resource system of the traditional economic growth mode, becomes a new mode that is in accord with the concept of sustainable developing.

The author once presided the project and participated in initiating the conception on "knowledge economy" firstly (1984--1985), when working in UNESCO, and he is also the proposer of concepts of new recycle economics in China. His work *Recycle Economics* (English version) has been published by EffeElle Editori of Italy. The previous "3R" concept of the clean production has been extended and developed, and added new idea of "rethink" and "repair", which formed the new concept of "5R" for the new recycle economy.

- **Rethink**: Innovate the old theory of economics according to the scientific development viewpoint.

The key points of new economic theory are not only founded on the recycling of capital and labor, but also resources. The aim of production is to create the new fortune for society, as well as to repair and maintain the ecosystem, which is a destroyed critical fortune of society, and to create the second fortune. The social wealth should not be increased completely at the expense of the decrease of nature fortune. When it increases rapidly with fast decrease of nature fortune, the social wealth should be input to repair the nature fortune; and after the nature ecology is repaired and its capacity increases, the social wealth will be re-produced under the new environmental condition. The two fortunes can be transferred into each other, which therefore, can promote the common development. –

This kind of development can be recognized as a sustainable development, and can realize the harmony between human beings and nature.

Therefore, a simplex increase of social wealth without considering nature fortune is a "pseudo-developing". For example, if a luxury mansion is built in the desert, it is of no value as individuals cannot survive in the desert.

- **Reduce:** Set up new value viewpoints that are in harmony with nature.

The previous "reduce" means: promote the efficient use of natural resources to the largest extent; reduce the use of land, energy, water, and material. In fact, Theses concepts are correct and they have already been practiced during the post-industrialization of western countries, however, it is an understanding in narrow sense.

The new value viewpoint: the earth should not be treated as a dumping ground or simply as a raw material for use in manufacture. The previous concept should be extended to include reducing the demand of material within reason and "satisfying the needs, not the desire" as a means to improve the quality of life for human beings. The western view of economics of "maximum production and maximum consumption" or "satisfy the desire," should be changed into "reasonable demand".

- **Reuse:** Build the new viewpoint of resource optimization.

The original "Reuse" concept meant: extend the life span of product as much as possible, use one product in different ways, and reuse waste.

The new resources viewpoint: emphasize the comprehensive use of resources, make full use of renewable resources in enterprises and projects, strengthen the infrastructure and sharing of information resources, transfer traditional resource demand as dependent on rare and non-renewable natural resources to that using the rich and renewable resources. By this way the resource recycle can be realized.

In the mean time, enhance sharing of infrastructure facilitates and information resource. Develop "reproducing industry" which uses other enterprises' wastes as its raw material that does not input new resource.

- **Recycle:** Set up a new viewpoint of eco-industrial production.

The old "Recycle" means: the concept of the reuse of waste and recycling of resources in the process of production, which was mainly a recycling process inside the enterprise. It is necessary and has been carried into execution in the post industrialization of western countries.

The new industrial viewpoint: waste is a resource, a resource which is often handled in an improper way in an improper place at an improper time. The Economic system should be changed from the open and extensive chain to the closed and concentrated chain, to form the industrial and technological systems of the Recycle Economy.

For example, construct a new industry system utilizing of circulatory energy and solid wastes among thermo-electrical plant, steel-making plant and cement factories.

- **Repair:** Establish the new development viewpoint of repairing the ecosystem.

The ecosystem is not only the basis of social fortune but also the second fortune. Ecosystem, which is almost destroyed by social wealth production or other human activities, should be repaired continuously by ecological construction, and afterwards, when the ecology is repaired and its carrying capacity is improved, production of social wealth can be increased again. This process can form a benign recycle, and will reach harmony with nature.

Take the ecosystem repair engineering in the continental river basin as an example. The agricultural production and the expansion of oasis have caused river run-dry, and the underground water level of river basin descended. Through the implementation of ecosystem repair engineering, rivers re-flowed and the underground water level rose up. Afterwards can oasis expand and population increase and a new equilibrium could be reached. And in the condition of a larger oasis area, new ecosystem repair planning should be brought into effect so as to form a benign recycle of dynamic

equilibrium and harmonious development of human beings and nature.

Ⅲ. The Application of New Recycle Economics Concept in the Innovation and Economic Development

The differences between recycle economy and the former linear economy have required more innovation when implementing the recycle economy, which not only calls for technology innovation, but also the concept innovation and the developing mode innovation.

1. The Innovation in Beijing Olympics Projects

Following concept of "green, high-tech and people friendly Olympic Games" of Beijing 2008 Olympics, high technology will perform a crucial role to support the game. "Let the technology Olympics, and let Olympics promote technology", thus the technology innovation is recognized as the motivity and the ensuring for Beijing Olympics' concept.

Take the opportunity of Beijing Olympics to develop the national innovation system

After successfully bidding for 2008 Beijing Olympics, the "Science and technology planning for 2008 Olympics" and the "Science and Technology committee for the 29th Olympics" were founded in succession, which became the important leading force. According to the statistics, from 2001, there have been at least more than 60 Olympics scientific related project supported by the science and technology planning, which has covered fields like stadium construction, information and communication technology, sport science, energy and environment protection, transportation, etc. Participants included enterprises, universities, research institutes and some relating organizations. Some projects would be completed through cooperation of universities and enterprises, and most projects will have broad and long-term market future after Olympics. Presided by the government

while collaborated by universities, research institutes and high-tech enterprises, those activities have covered most departments of the national innovation system, which will promote the interaction among the government universities and enterprises through national level events to support forming China's national innovation system.

Take the opportunity of Beijing Olympics to promote the independent innovation ability of China

Most originality of the Olympic stadiums came from the cooperative design of domestic and foreign experts, however, whether the design scheme perfecting, the framework calculation, or the selecting constructing techniques and enacting quality standards, are completed independently by Chinese. Relying on the force of independent innovation, construction of Olympic stadiums represented by "Bird's Nest" (National Stadium) and The "Water Cube" (National Swimming Centre) was carried out successfully. For example, the originality of the "Water Cube" was from cell arrangement, and the bleb or lathery structure. Though commonly seen in nature, such form has never appeared in the architecture structure before. The first building to realize such polyhedron structure in the world, the "Water Cube" has made contribution to the international architecture arts. 100 thousand m^2' membrane structures of the "Water Cube" has exceeded the 70 m^2' one of Munich Stadium, and also is the first one in the world to use membrane as the functional out-cover other than just ornaments, and the acoustical requirement of high quality has realized under such condition. During the construction work, most difficult problems are solved by Chinese technicians, and they have enacted some technical standard in the construction work for the Olympic stadiums, as there were few specific standards for the stadium constructing. A series of new technical standards have formed during the construction, which will become the precious intellectual property for the domestic architecture engineering. All above are the fruits of technology innovation and the independent innovation by the Olympic projects, for they provide broad stage for the Chinese innovation in construction engineering.

2. Innovation in the city construction

When the new recycle economic concept implement in city construction, principles of sustaining the ecological equilibrium and constructing the environmental friendly city which in harmony of both residents and ecology. The innovation in city construction mainly lies in a few city ring net system.

Water Circle System

- **Should the City be Built Close to the Water or Far Away?**

Today, city construction should be built close to water or far away? We should carry out the systematic analysis following principles of the recycle economy:

1) The benefit in water supply and transportation when building city close to water will exceed the cost of the embankment construction for preventing serious flood;

2) Consider thoroughly the ecological benefits by water flowing across the city.

3) The principle for building embankment is to avoid the "hanging river"

4) Flood prevention facilities which are built close to the river should not be simple like embankment, adequate areas for maintaining flood should be retained, which could be used as parks, playground or golf course in non-flood period.

- **Guarantee Adequate Water Surface**

Water is a fundamental natural resource and the source of ecosystem. Large number of residents gathered in man-made cities, thus the water area per person in these cities is quite different from those who live in countryside that depends more on the natural ecosystem. In order to guarantee a good recycle and living environment of city ecosystem, we should assure certain amount of water surface for each person. According to international experience, 4 square meters' water surface per person is generally appropriate (multiply a coefficient for comparatively larger rivers). This figure in Beijing was approximately 5 square meters per person in 1950s, but decrease dramatically to 1.5 square meters per person today.

The water area of city has exerted several functions such as sand proof, dustproof, changing

microclimate of a city, preventing the Tropical Island Effect and beatifying the living environment, etc. The construction of city water area should utilize the mid-water as much as possible. The ecological benefit of flowing water is much higher than that of the stagnant water, which depends on the position of the river path, the area of river and the water volume. If this water quality can reach a certain standard, which is rank Ⅲ, its ecological benefit per square meter will exceed that of 10 square meters' stagnant water. Reusing of reclaimed water is the main source to expand the water area of the city.

- **The City's River can't be Used as the Water Pipe or Sewer**

So far, rivers have been used as the water pipe and the sewer at the mean time. In the countryside during the agricultural economy era, land was wide but sparsely populated, and chemical fertilizer had not been used. So this way employed the self-renovating power of ecosystem, and it was scientific and reasonable. However, in cities of industrial economic times, it is beyond the bearing capability of ecosystem to do so. Therefore, in the construction of water cycle system, not only should the sewerage be needed, which drain the sewage away and should lie far away from the diversion canal of waterworks, but also should the self-purifying ability of river be calculated according to the water flowing speed, and should the sewage be arranged scientifically. The sewage can be drained to long distance away or deep sea if necessary, and inland cities need to raise the degree of processing the sewage in order to assure the water quality of city's water cycle system.

- **Take the City's Ground Water into Consideration, and Establish the Recycling System of Surface and Ground Water**

Regions of the city also have a water ecosystem composed by surface water, soil water and ground water, so the city cannot be cemented entirely, that is "to be completely petrified", which will cut off the source of ground water and destroy the water cycling. Except land left for the green belt, the crushed stone or wood chips should be used in place of cement by every means possible, or using seeping bricks if cannot be replaced. This can ensure the water cycling as well as mitigate the Tropical Island Effect to the city. To cement entirely was the concept during the traditional industrial economic times, but nowadays, following the concept of recycle economy, developed countries have already begun to change such conception, and try not to cement the land as possible.

- **The Reuse of Mid Water and Supply Water at Quality Appropriate to the Respective Use**

Water shortage is a serious problem in many cities. One of the main approaches to solve this problem under the concept of recycle economy is to reuse mid water. In many cases, reusing mid water is better than draining water away. Not only does this accord with the concept of recycle economy, and may the input be less, but also mid water is a stable source of water.

From the point of the macro-system of the cities that was short in water, supply water by qualities should be advocated to promote the positive recycle of water using. In fact, only the water used for drinking and bathing water should reach the standard of drinking water, the other can be sufficed by reclaimed water. Using the mid water in communities requires supplying water by different qualities. Therefore, it's reasonable to establish a multi-qualities water supply system. The problem is that altering current water supply systems need too much input. So, it is suggested that the new communities use new system while the old one still use the former system, and the elders and kids can be taught to prevent confusions.

- **Build the City's Water Ecosystem**

To build the city's water ecosystem is to set up water circle system. Currently, most big cities in China have already begun the constructing work. For the Beijing 2008 Olympics, an activity called 'Return green rivers to their nature ecosystem; Let clean water encircle Beijing' was conducted, which will increase the average water surface for individual from the current 1.5 square meters to nearly 4 square meters. For the Shanghai 2010 World Exposition, a program aiming to construct the sides of Huangpu River has been put forward. And the government of Tianjin also proposed to renovate the Hai River to the first river among the Asian cities.

All this is conducted under the concept of recycling economy, and is aimed to combine the construction of city water ring net with recycling economy to form the positive cycling.

The Green Net

The green net of the city recycles the city airflow. The recognition of the construction of the city's green net ecosystem also has experienced a historical process.

- **The Green Land of the City**

Because of the highly concentration of people in the city, it has discharged large amount of CO_2 in the daily life of human. It is the green plant that transfer CO_2 to O_2, maintaining the benign cycle of the ecosystem in the city, so that the human being can enjoy a comfortable environment. Therefore, it is critical to keep certain area of artificial green land inside city, which is an important index accounting for the level of ecosystem in the city. The area of green land per capita of Beijing is only $10m^2$, according to the standard made by United Nations Environment Program, which is $50m^2$ per capita, while in Berlin and Warsaw the number is over $80m^2$, there is also a problem about the standard, what is most important is weighing benefit of the ecosystem. The statistics of the green land should be included inside planning district, and when it comes to the outside district, the number should multiply a coefficient less that 1, which is descending with the distance to the center of city. There is formula:

$S_{equivalent}=e(d)/S_{outside}$

$S_{equivalent}$ is the equivalent value of the area outside city's planning area. $S_{outside}$ is the area of green land outside planning area; e(d) is the equivalent index, which is also the function measuring the distance from the center of the city, descending as distance is longer.

- **Planting Tree or Grass in Beijing?**

Beijing is located in semi-humid region, temperate zone of monsoon climate, and covered by arbor, frutex and grass. Because of the overpopulation, the underground water level drops year after year, only equivalent to the low border of the semi-humid region at present, it is difficult to maintain the meadow of the semi-humid region. So the artificial vegetation in Beijing should rely mainly on the planting of bush and trees that could endure drought. Keeping grass land in certain amount, while chose the grass that could withstand drought also. This is the most commercial way. In fact the best object of reference is the local primitive or secondary vegetation system. According to mountain area around Beijing, it should be the vegetation system that arbor, frutex and grass planted together.

3. The industry innovation considering Beijing's Characteristics

Beijing has become the political and economic center of China since 1949, but it ought to become the new economic centre in future by developing recycle economy and knowledge economy. Therefore, the government of Beijing has proposed that to increase the proportion of high tech industry to a quarter of GDP, and to change the traditional industry structure.

Urban Industry Chain

One outstanding characteristic of recycle economy is to change the previous linear and unidirectional industry chain to the "eco-industrial chain" according to current features of industry structure. There is an example of water recycle. Water industry is the easiest industry to form a recycle chain. The city water industry can realize water resources circulation by forming a close industry chain through putting operational reservoir, tap water factory, Water Supply Company, drainage Water Company, sewage disposal factory and mid-water company all together. Please see chart 1:

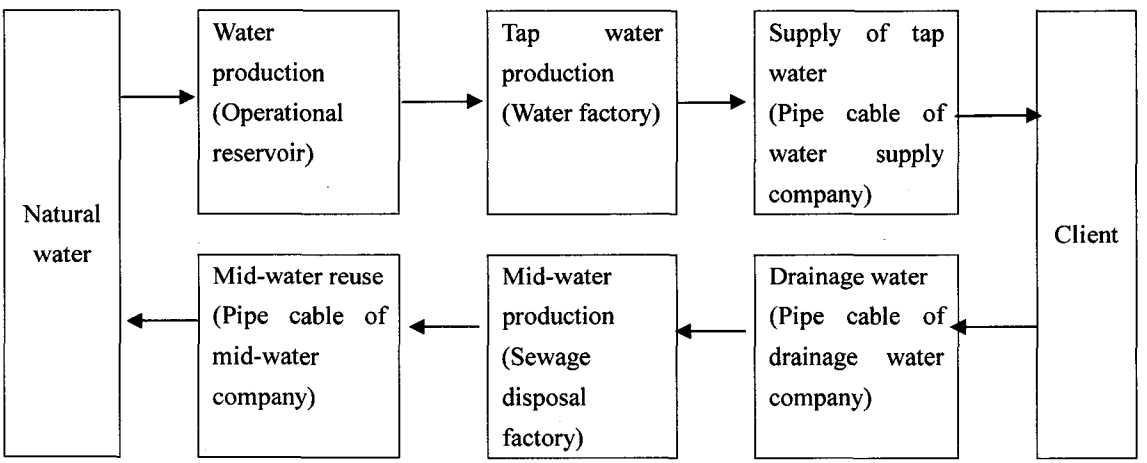

Chart 1. Close Cycle of Water Industry Chain

The high tech economy represented by Zhongguancun Science Park

The high tech industry is the stanchion for knowledge economy. Zhongguancun Science Park,

which accounts for nearly 20% of Beijing's GDP, has already gained international fame. And in future Zhongguancun Park will be the prosperous region for developing Beijing's high tech industry. The high tech economy calls for innovation in two aspects: firstly, how to activate the university's role in the triple factor (enterprises, university and the government) of the science park; secondly, motivate the enthusiasm of innovative talents in universities and research organization by establishing the agency system, thus to enhance the independent intellectual property in high tech products.

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