

Chapter 2

Green Growth: Constructing a Resource-Saving and Environment-Friendly Production Pattern

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In the 12th *Five-Year Plan of China*, “Changing developing mode and striving to create a scientific development pattern” has been specified as the theme of national economic and social development. Meanwhile, as the focus of accelerating the transformation of the economic development pattern, the building of resource-saving and environment-friendly society has also been emphasized. Obviously, the green economic growth is of extraordinary importance in forming a resource-saving and environment-friendly society, and is an inevitable choice in coping with increasingly serious resource and environmental constraints. In pursuit of a green growth, endeavors on enhancing the sense of environmental crisis, accelerating energy saving and emission reduction, and constructing an energy-saving and environment-friendly production pattern are urgently needed. Besides, there is also a fundamental need for the green growth mode to perfect the price forming mechanism of resource products and the resource-environment tax system, and therefore establishing a rational pricing system.

2.1 Green Growth: The Key to Building a Resource-Saving and Environment-Friendly Society

The issues of resource shortage and environmental pollution are becoming the major constraints that obstruct China’s sustainable development. In this context, the building of resource-saving and environment-friendly society plays an important role in accelerating the transformation of economic development mode. This new development mode pays more attention to resource saving and environmental protection both in producing process and households living. As China is still in its rapid industrialized phase, developing a resource-saving and environment-friendly production pattern and propelling a green economic growth are the major tasks in realizing a resource-saving and environment-friendly society.

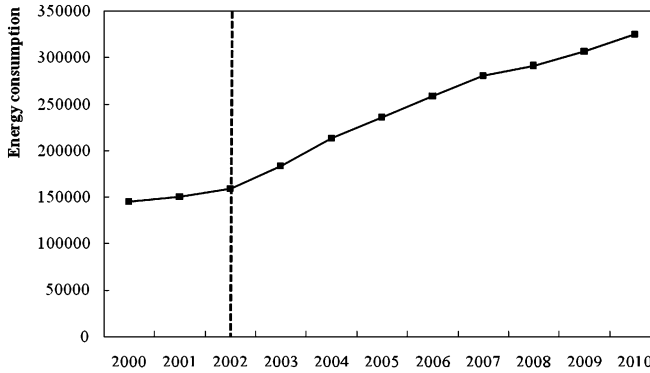


Fig. 2.1 Energy consumption of China from 2000 to 2010. *Source* Website of National Bureau of Statistics of China

2.1.1 Resource and Environmental Limitations in China

In recent years, China has experience a rapid development both economically and socially, which is reflected by fast economic growth, improvement of the standard of living and considerable progress on social undertakings. However, simultaneously, the deterioration of natural resources and environment is the price to pay for the socioeconomic development, including the huge consumption of natural resources such as water, energy and earth, the emission of environmental pollutants, and the severe destruction of our natural ecological environment. To make clear the extent of resources consumption and environmental pollution, two indicators, i.e., energy consumption and CO₂ emission are utilized. Figure 2.1 shows the trend of energy consumption in China in the last 10 years.

As demonstrated in Fig. 2.1, there is an uprising trend of energy consumption from 2000 to 2010. This trend is most notable from 2002, due to the increasing development of heavy chemical industry in China and energy consumption was thereby largely required, (The vertical line in Fig. 2.1 represents the turning point of the increasing rate of energy consumption). From 2002 to 2008, the energy consumption kept in a growth rate of >8 %, and the highest one even reach 16 %, which has surpass the growth rate of GDP. This trend was kept until the year of 2008, when the world was stricken by the global financial crisis.

On the other side, huge amount of energy consumption and accompanied wastes and emissions have exerted great pressure on environment, threatening people's quality of life and obstructing the sustainable development process. Owing to the large number of energy consumption, CO₂ emissions in China present a stably increasing trend and roar to the largest CO₂ emitter worldwide. The large amount of CO₂ emissions in China not only make great contribution to global warming, but also have China accused and constrained by some

Table 2.1 The ratio of energy reserve to production (RP ratio) of China and the world

| Energy type | Reserve | Production | RP ratio of China | RP ratio of the world |
|-------------|--------------------------------------|---------------------------------------|----------------------|--------------------------|
| Raw coal | 1.145×10^{11} ton | 3.24×10^9 ton | 35 | 122 |
| Crude oil | 2.1×10^9 ton | 2.03×10^8 ton | 10 | 42 |
| Natural gas | 2.46×10^{12} m ³ | 9.676×10^{10} m ³ | 25 | 60 |

Source BP statistical review of world energy 2010

international organizations and other countries. Therefore, in the long run, CO₂ emission will remain a significant problem that needs to be addressed in no time.

Resource and environment carrying capacity is facing increasingly severe challenges due to irrational resource consumption and environmental pollution. As to the resource consumption, taking energy utility as example, according to the statistical data of BP (2010), China’s economic recoverable reserves of coal, oil and natural gas are 1.145×10^{11} , 2.1×10^9 ton and 2.46×10^{12} m³ respectively in year 2010. However, energy production in 2010 sets a new record. The production of raw coal has reached 3.24×10^9 ton with a growth rate of 9 %. With regard to crude oil, a breakthrough has been made with the production of 2.03×10^8 ton and growth rate of 7.1 %, which is the highest growth rate in the recent years, and natural gas production is up to 9.676×10^{10} m³ with a growth rate of 13.5 %. Thus, it can be calculated that the reserve and production ratio (RP ratio) of coal, oil and natural gas are 35:10:25, which is only 29, 24 and 42 % of the world’s average, as shown in Table 2.1 and Fig. 2.2. Evidently, resource constraint creates a great challenge for the sustainable development of Chinese economy and society. Specially for crude oil, if the reserve keeps unchanged, it is only available for another decade or so even if we hold the current mining scale. Energy bottleneck is, thereby, around the corner.

In terms of the environmental degradation, through past 3 decades, rapid industrialization has also imposed enormous pressure on the environment. Specifically, air, water quality and soil are under severe degradation due to the emissions of toxic gas, sewage and wastes, thereby resulting to the ecological damage and abominable human living condition. The data published by the Ministry of Environmental Protection of China indicates that China was of poor air quality, especially around the cities of concentrated heavy industries and high population density like Beijing and Tangshan. On the other hand, the degradation of water quality directly exerted impact on water use security. Watersheds in China that reached the first grade of water quality standard only constitute 4.6 % of the total river length, and the watersheds of inferior-V grade approach 20 %. A quarter of people are kept from clean drinking water. One third urban residents have to bear with dirty air. It is clear that most of the population is exposed to a degraded environment with low quality of air, water and soil. In recent years, the severe environmental and ecological problems have inflicted great damage on economic development, more fatally, on human life and property.

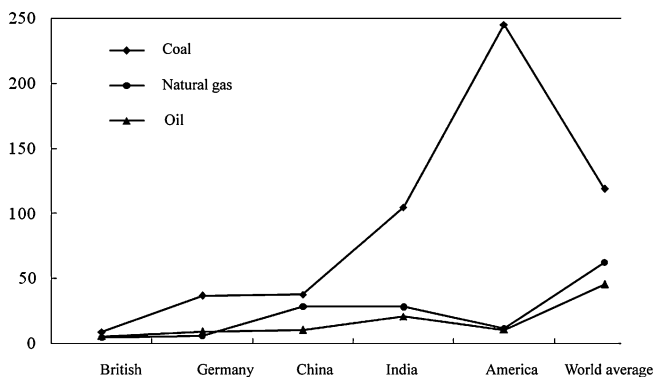


Fig. 2.2 The RP ratios of coal, oil and natural gas of main countries in 2009. *Source* BP statistical review of world energy 2010

2.1.2 Core Reasons of Resource and Environmental Problems

As discussed in Sect. 2.1.1, intensive resource consumption and environmental pollution tremendously threatened the carrying capacity of resource and environment. As China is still at its increasing industrialization stage, resource use and environmental emissions are mainly attached to the production process, i.e., large amount of resources are consumed for creating GDP at the cost of severe environmental pollution and ecological damage. This phenomenon reflects the extensive characteristic (intensive energy consumption, high environmental pollution and low utilization efficiency) of China's economic growth. Since the reform and open up policy in the 1970s, China's economic growth rate has reached 9.9 %. The continuous high-speed economic growth has attracted considerable attention globally, reckoning it as "the miracle of China". However, at the same time, the quality of this economic development has somewhat been doubted, with increasing attentions paid on resource consumption and environmental pollution in the process of such growth.

Here we first employ energy intensity as an indicator to reflect the energy efficiency of the economic development in China, i.e., energy consumed per GDP. Figure 2.3 indicates that the economic development in China is still characterized as the extensive and inefficient mode. Energy utilization efficiency is relatively low compared to that of developed countries. As shown in Fig. 2.3, energy intensity in 2009 stayed in a high level, which was around 5 times of German and Japan, and 3 times of the U.S. The high-energy intensity reflects huge resource cost behind economic development and indicates the unsustainability of current developing mode. These have brought huge negative externalities which needs to be further addressed.

Another concerned indicator is energy supply per GDP which is defined in the China Statistical Yearbook, it could represent the gap among China, the average of the world and major countries from the angle of energy supply. As shown in

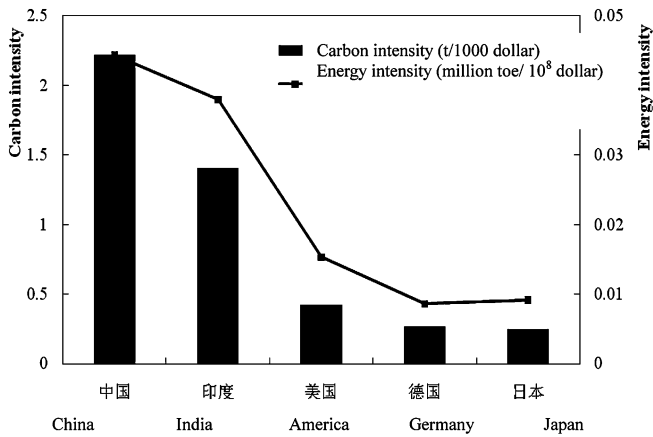


Fig. 2.3 Energy intensity and carbon intensity of major countries in 2009. *Sources* Energy intensity comes from WDI database of World Bank, which is calculated by PPP of 2005. Carbon intensity is obtained from EIA and is based on the price of U.S. dollar in 2005

Fig. 2.4, energy supply per GDP in China and India is higher than those of the average level of the world and other major developed countries. Specifically, the energy supply per GDP in China is 2.7 times of the world, 4 times of the U.S., 4.5 times of OECD countries, 4.5 times of French, 7 times of the U.K., and 8 times of Japan.

In addition, CO₂ emission per GDP could also be employed to represent the environmental cost of economic development. The changing trend of CO₂ intensity in Fig. 2.3 indicates that current economic growth mode has caused large amount of greenhouse gas emission as well as huge ecological pressure, which has attracted attentions from the whole society. As shown in Fig. 2.3, China’s carbon intensity is one of the highest values in the world, not only higher than the developed counties, but also higher than some developing countries like India as well as the world average value. In 2009, the carbon intensity of China is about 5 times of the U.S., more than 8 times of German, and 9 times of Japan. This giant different depicted in Fig. 2.3 reveals the ignorance of environmental protection of China in pursuit of economic growth and also a great promotion potential in reducing carbon intensity.

2.1.3 Essential Requirements to Harmonize “Green Environment” and “Economic Growth”

In the face of intensified environmental and resource constraints, a sense of crisis should be enhanced, as well as the awareness of green and low carbon development. Moreover, the implementation of “energy saving and emission reduction”

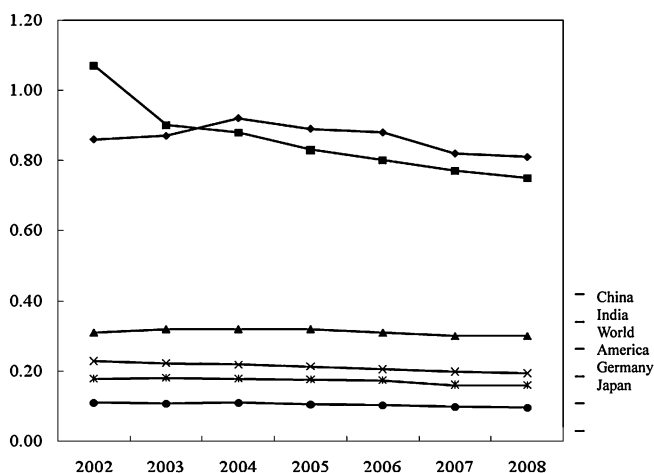


Fig. 2.4 Energy supply per unit GDP of some major countries toe/1,000 dollar, calculated by the 2000 price. *Source* China energy statistical yearbook 2010

should be further intensified. Meanwhile, we should consider that China is still a developing country whose GDP per capita is less than half of the world's average, one tenth of developed countries, and ranks 100 in the world (China's GDP was converted into 3,761 dollars which is less than half of the world in 2009 with the exchange rate of 6.8 between RMB and U.S. dollar).¹ This indicates that China should keep attaching importance to economic development. The problem is: how to cope with the contradiction between economic growth and resource saving and environmental protection? The only solution to this is transforming current economic growth mode to a resource-saving and environment-friendly one.

Countermeasures for resource saving are: (1) Restrain the rapid growth of energy intensive industries, and highlight the importance of energy saving in industry, construction, transportation and public institution. Management on energy saving should also be emphasized in high-energy-consumption enterprises. In addition, some regulations and incentives such as energy management contract, demand side management, energy efficiency label policy, energy-saving certificate. And the mandatory procurement of energy-efficient products should be perfected and promoted. Moreover, advanced energy-saving technology and products need further promotion. According to the 12th *Five-Year Plan*, a 16 % decrement in energy intensity in the end of 2015 is required compared to the level of year 2010. (2) Strengthen the efforts of water resource saving. We should carry

¹ Ministry of foreign Affairs of the People's Republic of China: Per capita GDP of China is less than half of the average level of the world. 2011.02.15.

<http://finance.ifeng.com/hk/sckx/20110215/3409279.shtml>.

out a rigorous water resource management, enhance volume control and quota management of water resource, speed up the establishment of water distribution program of river basins, reinforce the construction of water right system and water-saving society, improve industrial water utilizing efficiency, and finally, update water-saving technologies of key water-consuming industries and guiding the water-saving behaviors of local residents. (3) Make use of the land economically and intensively. For arable land, measures such as insisting on the most rigorous arable land protection policies, designating permanent basic farmland, establishing protection and compensation mechanism and strictly controlling the occupancy of arable land by construction activities, as well as keeping the balance between farmland occupation and complement according to the policy of “supplement first and occupation follows” are of great significance to make sure that the total quantity of arable land is not declined. In addition, policies on land use saving should be executed rigorously to control the whole construction scale. According to the 12th *Five-Year Plan*, the construction land per GDP should be decreased by 30 % in 2015 compared with that of 2010.

In order to implement the target responsibility system for energy conservation and emission reduction, and reinforce the control of pollutants, environmental protection is also emphasized in the 12th *Five-Year Plan*. Main pollutants were added up to four rather than two, i.e., COD, ammonia nitrogen, SO₂, NO_x, in which the emissions of COD and SO₂ are planned to decrease by 8 %, while the emission of ammonia nitrogen and NO_x are planned to decrease by 10 %. Before this, only COD and SO₂ are employed as binding indexes in environmental monitoring. However, with SO₂ controlled, NO_x has become the main air pollutant in recent years, the incorporation of ammonia nitrogen and NO_x is important for the enlargement of the environmental protection and the total-quantity control of pollutants discharge. Besides, a 17 % decent of CO₂ intensity is also requested in the 12th *Five-Year Plan* to cope with the global warming issue.

2.2 Constructing a Resource-Saving Production Pattern

The meaning of constructing a resource-saving production pattern is to prioritize resource saving in the production process, to improve resource consumption efficiency, to lower resource consumption intensity, and to obtain the largest economic benefit with least cost. The first step for this is to intensify the control of total resource consumption and avoid irrational exploitation. After that, it is also essential to rationalize the pricing system of resource-based products and use price mechanism to optimize the allocation of scarce resources. Circular production pattern is also regarded as a promising approach to improve the efficiency of resource use and reuse.

2.2.1 Intensifying the Control of Total Resource Consumption to Avoid Disordered Exploitation

The principle of “Use the resource in a fast speed” has long been followed in resource exploitation and utility, resulting in excessive and disordered resource exploitation. To cope with gradually serious resource constraints, efforts should be spent on intensifying resource consumption control, especially for the non-renewable and scarce resources. In the 6th session of Chap. 22 of the 12th *Five-Year Plan*, the requirements of “to prioritize resource-saving and resource consumption regulation...to promote the security level of resource utility” is highlighted.

With respect to energy saving, the key point is to control the total amount of nonrenewable fossil fuel supply. According to the total—amount—control target of the 12th *Five-Year Plan*, primary energy consumption should be controlled under 4×10^9 ton, in which coal consumption is assigned to 4×10^9 ton with net import of 2×10^8 ton, while oil consumption is assigned to 5×10^8 ton with net import of 3×10^8 ton. Therefore, during the period of the 12th *Five-Year Plan*, the control from resource and energy consumption on domestic oil and chemical industries will be obvious in China. In all, the rational management of total energy consumption is the key to developmental mode transformation.

As to water resource, volume control and quota management of water resource should be enhanced, and water distribution plan of river basins and water right system should be established as well. For land resource protection, the establishment of land use plan should be accelerated, so as the protection of arable land and the control of total construction land. In terms of minerals resource, the protection and exploitation management of dominant mineral resources should be attached more importance to. In addition, we should strive to perfect the compensation systems for use of mineral resources. Moreover, by executing the partition management regulation of mineral resource planning, rationally allocating mineral right, and optimizing the distribution of geological exploration and exploitation of mineral resources taken, we could keep the exploitation of mineral resources coordinate with the development of social and economic development and therefore improve the sustainable supply ability of mineral resource.

2.2.2 Taking Advantage of Pricing Mechanism for Optimal Resource Allocation by Streamlining the Pricing System of Resource Products

The extensive and inefficient economic growth mode in China is rooted in the fact that the twisted market price fails to deliver the exact signal. A low resource price may result in the abnormal demand and a waste of resources, leading to the

overdevelopment of energy-intensive industries. Considering the pricing mechanism of resource products one step further, we could find that the twisted resource price originated from the blurred definition of resource property. At this stage, there is still no clear definition on resource property in China such as land, water, minerals and energy sources. It is difficult to adjust prices efficiently due to the lack of a mature market that reflects the actual demand and supply of these resources. As a result, the existing pricing mechanism fails to reflect the scarcity and cost of resources, which results in extensively relies on resource exploitation and input. A high input, high consumption, high pollution and low efficiency growth route has emerged. This growth mode makes the environmental and resource problems more and more severe and thus diminish the marginal benefit of economic development. In addition, the path dependence strengthens the inertia of the pricing system, and it lacks a motivation for the entities of market to rectify their behavior and promote the institutional changes. In conclusion, establishing a sophisticate resource pricing system and define the price as a reflection of scarcity and value of resources is not only an essential way to the building of resource-saving society, but also a fundamental approach in transforming economic growth mode and solving resource and environmental problems.

The general direction of resource pricing system reform in China is to clarify the resource property, to rationalize the relations of prices, to keep marketizing, and to make use of the fundamental role of market in resource allocation. Another is to make the price a reflection of resource scarcity, supply and demand balance of market, and the externality of resource and environment, thus fostering the transformation of economic growth mode and the adjustment of industrial structure in support of the built of resource-saving society.

Firstly, to clearly define the resource property. As soon as the property rights determined, the market-oriented reform will work. This has been emphasized in China's 12th *Five-Year Plan* as "Bringing in the market mechanism, establishing compensation and transaction systems for the mineral property, standardizing the development of transaction system of mineral exploit and mining right, and supplementing the laws and policy system to realize the well organization of resource and environmental property rights and achieve open, justice and fair transaction mode". To clarify the resource property, we should pay attention to the following issues: firstly, the affiliations of all the rights should be determined, including the distribution and partition of resource ownerships, utility right, current right, and so on. After that, different property right systems should be established in accordance to different kinds of resource. Regarding the resources whose property are difficult to determine, we should designate its public nature and open both the current and utilization right and management right of the first grade market to realize the compensative resource use. Also we should open the current, utility and the management rights of the second grade market to the resources with definite property right, cultivate the market system of resources, improve the marketization degree of resources and optimize the resource allocation mode. By optimizing the

resource property right system, we can realize the capitalized management of the resource property, and separate the ownership and management right. In addition, rights and obligations should be determined in the format of legal contract to realize the compensative use of resources, and guarantee the right of a country as the property owner. Meanwhile, it is essential to optimize the resource exploitation and mining in pursuit of sustainable socioeconomic development.

Secondly, to rationalize the price relations, especially the proportional price among energy sources. Attentions should be paid to adjust the price relations among different energy sources to maintain them to a reasonable level, and avoid extensive demand or contradictions of supply and demand brought by low price relations of one kind of energy sources, i.e., price delivers wrong signals. In China's 12th *Five-Year Plan*, the request has been proposed as "rationalizing the price relation between natural gas and the alternative energy sources". Moreover, converging with the international price is also required in rationalizing price relations, especially for the energy sources that are prone to be influenced by the international market, e.g., petroleum products. Price should be adjusted step by step towards the price level of the international market and finally realize the price convergence to the international level.

Finally, based on the previous two steps, we should insist on the market-oriented reform to make full use of market in optimizing resources allocation. Specific practice is that we should break the resource monopoly management pattern by bringing in the competition mechanism and untying the governmental control. To ensure smooth operates of the market, we should establish and optimize the operating principles, create a fair and open atmosphere and form a unified, open, and well-organized resource market. The 12th *Five-Year Plan* has pointed out that "In order to propel the rational exploitation and resource use, we should increase the resource tax bearing properly, perfect the assessment and imposing mode, and transform the fixed quantity imposing way, which is based on the quantity to the fixed rate imposing way according to the linkage mechanism of price, tax, fee, and rent."

Once the resource pricing system is established, price will play a role in delivering signals about supply–demand balance and scarcity of the market, based on which the optimal resource allocation can be obtained. On this basis, in order to reduce production costs, each economic entity spontaneously should employ multiple approaches to improve the resource utilization efficiencies, thus providing intrinsic motivations for resource-saving efforts. Under such circumstance, each economic entity will rectify its behavior automatically and stick to principle of Reduce, Reuse and Recycle. Also it is important to prioritize the principle of reduction, to improve the resource yield efficiency, to promote the circular production pattern and establishing the resource recycling system. Only by adapting these measures, the whole society can be accelerated to the economic transform, and the strategic goals of the 12th *Five-Year Plan* and the transformation of economic growth mode can be realized.

2.2.3 Striving to Develop the Circular Economy by Production Pattern Innovation to Improve the Comprehensive Resource Utilization Efficiency

The 12th *Five-Year Plan* has pointed out that the circular production pattern will be promoted in the next 5 years. Industrial parks will be planned, constructed and rehabilitated according to the requirement of circular economy. It is also needed to obtain the intensive land use, waste exchange and reuse, cascade energy utility, waste water recycle and centralized pollutants handling. Finally, by propelling the circular combination of industries and constructing an inter-linked and cycling industrial system, the resource output ratio is expected to increase by 15 %.

In terms of agriculture, the transformation should be achieved by developing the circular agricultural production pattern and constructing an inter-linked circular economic system of high-efficiency. New agricultural modes such as ecological agriculture, stereoscopic agriculture, green agriculture, organic agriculture and recreational agriculture are highly suggested in this case. In the development process, based on the principle of “low exploitation, high utilization, low emission and reuse”, we should make full use of materials and energy that entered the production-consumption system, improve the operation quality and efficiency of the whole system, and realize circular and high-efficiency energy and material utilization. With all these measures implemented, the coordinate development between agriculture and resource and environment is expected to realize, as well as the sustainable agricultural development.

As to industry production, propelled by the impetus from the regional planning, enterprises’ self-discipline and government supervision together, we should accelerate the transformation of enterprises towards a circular production pattern. Such production pattern could be interpreted that in an industrial park, in which the wastes and by-products of an enterprise are used as the input and raw materials of another enterprise. By means of waste exchange, circular utility and cleaner production, the increase of resource use and energy conversion efficiency, and waste emissions reduction (even zero emission) can be obtained. To realize circular economy, measures on weeding out outdated production pattern should be taken, accompanied with adjusting industrial structure and realizing the innovation of production pattern. These measures are essential to transform the current low-efficiency and high-pollution production pattern to the circular economy mode of high-efficiency and low-emission.

Finally, a complete resource pricing system can foster the establishment of resource recycling and reusing system. The 12th *Five-Year Plan* proposed that in order to promote the large-scale renewable resource use, we should complete the recycling system of renewable resources, accelerate the construction of “Three-in-One” recycling network that covers the recycling sites, sorting centers and terminal markets of urban communities and rural areas. In addition, measures such as completing the recycling system of old components remanufacturing, propelling the development of remanufacturing industry, establishing the garbage

sorting and recycling system, perfecting the sorting and recycling, airtight transportation, concentrated disposal systems, and promoting the recycle and harmless treatment should also be paid great attention to.

2.3 Constructing an Environment-Friendly Production Pattern

As long ago as 1992, the concept of “Environment-friendly” has been formally proposed in Agenda 21 in United Nations Conference on Environment and Development (UNCED) in Rio. In the mid- and late 1990s, the international society put forward a set of concepts such as environment-friendly land use, environment-friendly basin management, environment-friendly cities, environment-friendly agriculture and environment-friendly building. In 2004, the Japanese government was ambitious to build the environment-friendly society in the “White Paper on the Environment”. As for China, President Hu Jintao appealed to build the environment-friendly society in the Symposium on Population, Resources and Environment in March, 2006. Afterwards, in the Fifth Plenary Session of the 16th CPC Central Committee, the building of resource-saving and environment-friendly society was officially designated as a strategic task of the mid-term and long-term planning on national socioeconomic development. In this year, the topic of the sixth chapter of the 12th *Five-Year Plan* is entitled as “Green development, building resource-saving and environment-friendly society”. Therefore, the construction of an environment-friendly production pattern was put in an unprecedented high place.

Environmental problems in China are gradually deteriorating accompanied with the development of economy and society. Since the reform and open up policy in China, with the rapid economic development, industrialization and urbanization consumed a large amount of resources and exerted great pressure on the environment. The contradiction between economic development and resource and environment is thereby becoming increasing prominent. Environmental problems emerged periodically during hundreds of years in developed countries have concentrated within the last 30 years in China. These environmental issues can be characterized as structural, compound and compressed type. Now, environmental degradation is becoming the focus of the public, social consensus and international society, and environmental security is becoming an important component and guarantee of national security. Therefore, in the next decade, as new environmental problems will continue to emerge, and emergencies and hidden danger may keep increasing, social conflicts caused by environmental issues will correspondingly erupt and increase. The task of pollution control and ecological protection will be increasingly difficult. Thereby, how to coordinate the relation among economic growth, social development and environmental protection is an unprecedented challenge that China has to face. To construct an environment-friendly production pattern and harmonize human activities with the nature, we

should comply with the requirement of *Scientific Outlook on Development*, transform economic growth mode fundamentally, and step on a new industrialization way.

The environment-friendly production pattern emphasizes environmental impact, aspect and highlights that human should control the production intensity within the environmental capacity. This production pattern is a new way that aims to form a key feedback mechanism for the entry of production and consumption activities by altering the eco-environmental factors in quality and state. Specifically, it supervises the whole process of production and consumption by means of analyzing the mechanism of metabolic waste production and emission. In addition, multiple measures are adopted in this production pattern to reduce the amount of pollution, and realize anti-harm pollution, and ultimately to reduce the passive impact of the socioeconomic system to the eco-environmental system.

Under current condition, in order to realize the transformation of economic growth mode and construct an environment-friendly production pattern, we should eliminate the structural and institutional factors that lead to environmental pollution and degradation, and rebuilt a society that could encourage the entity to protect the environment and reduce pollution spontaneously. By using economic, administrative and technological approaches, we are target to realize the construction and development of environment-friendly production pattern as well as a harmony relationship between economic growth and the environment in China.

2.3.1 Economic Approach: Environmental Tax and Trading System of Environmental Property Rights

Economic approach which plays a positive incentive role is regarded as a optimal way to solve problems. In order to build an environment-friendly society and transform the current economic growth mode, reforming on the environmental discharge fee system and environmental tax system, and establishing a mature environmental property rights trading system are of most effective.

The environmental discharge fee system in China has a history of 32 years. It is one of the earliest proposed and generally implemented environmental management strategies. The environmental discharge fee system requires the polluter to be responsible for the environmental damage by using economic approaches. This has been most contributive in aspects such as environmental emission reduction and the collection of environmental management capital. In the past, we used to employ environmental discharge fee system to protect the environment and use economic means to adjust the relationship between economic growth and the environment. Complying with the principle of “Who polluted, who solves”, the costs of environmental damage was required to be paid by the polluter. Through the past 3 decades, the gradually perfected environmental discharge fee system has made great contribution to the environmental protection of China. It was officially

established in 1979 in “The Environmental Protection Law of the People’s Republic of China (for Trial Implementation)”. The publication of “Interim Measures on the Collection of Pollution Discharge Fee” in 1982 by the State Council indicates the environmental discharge fee system was also established. According to this document, each province, municipality and autonomous region made their local measures and rules. Thus, a top-down law system on imposing pollution fee was formed in China. In order to adapt to the new environmental situation and new requirements on pollution abatement, “Management Regulation of Pollutants Discharge Fee Collection and Usage” was published by the State Council, corresponding rules and measures were also put forwarded, including “Management Rules of Discharge Fee Collection” jointly announced by the former State Development Planning Commission, the Ministry of Finance, the former State Environmental Protection Administration and the former State Economic and Trade Commission, the “Measures for the Collection and Administration of Pollution Discharge Fee” issued by the Ministry of Finance, the former State Development Planning Commission, and the former State Environmental Protection Administration, and “Notice on Reduction or Delay in Payment of Pollution Discharge Fee” published by the Ministry of Finance, and the former State Environmental Protection Administration. Computer management system for the pollution discharge fee has also been installed. Currently the pollution charges in China are imposed on items such as waste water, air pollutant, solid waste and noise, these pollutants are mainly embedded in industries like coal-based power generation, chemical industry, iron production, cement manufactory, papermaking, etc. In terms of regional distribution, pollution emissions of Jiangsu, Shanxi, Shandong, and Hebei province have all surpassed 1 billion RMB and make the top of the whole country.

Although the environmental discharge fee system has made great contribution to the environmental protection in China. However, with the development of economy and the promotion of environmental management, more and more problems start to impair the implementation. In this context, the environmental discharge fee system is no longer adaptable to current developing situation, and urgently needs to be reformed. The pollution charges in China were implemented by means of compensation on owing quantity. On account that it is in the primary stage of environmental tax, endeavor on adjusting and updating the tax system is essential. In addition, judging from the reform trend of environmental tax, the strategy of “substitution of taxes for fees” is regarded as the new direction of reform, which not only solves problems such as inequality, low efficiency and difficulties in operation, but also beneficial for environmental protection and economic transformation.

The 12th *Five-Year Plan* has clearly proposed that we should establish and complete the polluter paying system, increase the rate of pollution discharge fee, innovate the levy of waste disposal fees, appropriately raise the garbage disposal standard and the financial subsidy level, and perfect the levy of waste water treatment fees. However, the intrinsic limitation of the charging system inevitably leads to substitution of current pollution tax system. Thus, in order to take advantages of environmental tax system in the construction of environment-

friendly production pattern, we should follow the principles of tax legislation, tax neutrality, equality and efficiency, earmarking a fund for its specified purpose only and unified collection and allocation. It is also essential to construct a reasonable environmental tax system, to supplement relevant independent environmental tax types, and to make green improvements on previous tax types. Measures mentioned in the 12th *Five-Year Plan* include promoting the reform of environmental tax, conducting the levy of environmental protecting tax by choosing environmental items with big prevention difficulty and mature technical standards, and progressively enlarging the levy boundary.

In addition, the establishment of environmental property rights trading system should be accelerated in China, including property definition system, property allocation system, property trading system, and property protection system. Firstly, we should make a clear definition of the environmental property rights, i.e., make clear definition and institutional arrangement on various rights in the property system, including ownership, share and the distribution and allocation of all these rights. Secondly, it is essential to optimize property rights allocation system, which should be focused on the placement, proportional and combination of property rights possessed by different entities in a certain scope (including the distribution of central and local beneficial rights). Thirdly, we should promote the development of property rights trading system which is defined as the owners acquire the benefits through property rights operation based on certain procedures. Finally, we should accelerate the establishment of property rights protection system, i.e., constructing a legal protection system which constitutes of procedures on rights acquisition, principles of implementation, methods and the range of protection. Nowadays, the deficiencies of environmental property rights system in property definition, allocation, trading and protection have led to the fact that the social entities are not enthusiastic to reduce emission and protect the environment. As stated in the 12th *Five-Year Plan*, measures should be taken to promote the well-organized flow and equal, open and justice trading of environmental property rights, including bringing in the market mechanism, establishing compensative using and trading systems for the pollutants emission rights, developing pollutants emission property trading market, normalization the performance of pollutants emission rights trading price, and completing the laws and regulation system. These measures will provide strategic guidance and policy guarantee for the establishment of environmental property system.

2.3.2 Administrative Approach: Green Political System

A trend of solely pursuing the growth of GDP has long been dominated in China, especially that some local governments hold the unscientific viewpoints of “high input, high growth”, and “growth brings political achievements, political achievements bring leaders”. These misleading concepts and behaviors are the root of environmental problems. Specifically, these behaviors lead to the absolute ignorance

of the resource and environmental costs behind the economic growth such as the irrational resource consumption and environmental degradation. Obviously, the perceptual deviations and political faults directly result in the unsustainability of economic growth. Therefore, in order to construct an environment-friendly production pattern and realize the transformation of economic growth pattern, we should change our ideas and pursue the green growth mode.

Politically, a green administrative system should be implemented to guarantee the healthy economic development. However, if there lacks a solid institutional framework to guarantee this system, it will probably descend into a bunk in such a competitive and fast-developing society. Therefore, a green, scientific and sustainable administrative system is urgently needed. This system should compose of comprehensive, coordinated, sustainable and *Scientific Outlook on Development*, comprehensive view of political achievements and comprehensive decision making mechanism. Green cultural value, green and civilized administrative behaviors and regulations are also embodied in the green administrative system. Thus, it is regarded as the basic institutional guarantee of the building of environment-friendly society. Only with these basic institutions established and worked, the government is able to consider drawing up and implementing the environment-friendly management policies such as the green national economic accounting system, green political achievements examination system, green trading policies and green financial and tax policies. Via these innovations, the intrinsic incentives of all government officials will be totally changed, the concept of green administration will be commonly accepted and implemented, and the green growth and environment-friendly production pattern can be achieved at the governmental level.

In addition, except for the politicians and the government, the promotion of the green administrative system should also rely on the public. Therefore, democratization and scientific decision making should be in operation. In order to ensure that the public could really exercise the constitutional right and to protect the environment and the rights of the public, the core of green administrative system should be providing legal and administrative guarantee and support for the public. As a result, we should promote the democratization of environmental decision making, including propelling the disclosure system of environmental information and the legal system of environmental public interest litigation, and implementing significant environmental affairs public hearing system, etc.

Only by providing a green, scientific and sustainable administrative concept and the corresponding administrative system, the transformation of economic growth, the construction of environment-friendly production pattern as well as the harmony development of human and the nature can be administratively propelled.

2.3.3 Technological Approach: Green Technology

Science and technology is the primary productive forces and a powerful driving force for the development of the human society. Green technology is regarded as a kind of

environment-friendly technology, which roots in the harmonious and co-existence of human and natural ecosystem and plays important role in the construction of environment-friendly production pattern. The concept of green technology is derived from the Agenda 21 issued in the United Nations Conference on Environment and Development (UNCED) in 1992. This concept was further developed by the United Nations Educational Scientific and Cultural Organization (UNESCO) who indicated that “no technology, no sustainable development”. Now, green technology is defined as a new technical-economic mode which could combine environmental protection, ecological restore, efficiency improvement and economic development. As it plays an important role in fostering sustainable development, increasing attention has been paid to the green technologies. Now, a powerful trend concerning green technology and sustainable development has already emerged globally.

Three tiers constitute the green technology: Tier 1 indicates the pollution prevention and control technologies, including traditional end of pipe pollution control, such as the cleaner treatment technologies of waste water, gas and rubbish. Tier 2 is environment-friendly technologies, indicating technologies that can improve resource consumption efficiency and reduce pollutant emissions, including cleaner production, comprehensive utility of resources, and renewable technologies. Tier 3 are ecological protection technologies, which can improve environmental quality and maintain the ecological balance and enhance the eco service, including the technologies of ecological restoration, soil and water conservation, biodiversity protection and ecological landscape construction. Currently, the technologies of direct environmental protection are called “Deep Green Technology”, which consists of the technologies that specifically used in the treatment of environmental pollution, waste water treatment technologies and dust removal and desulphurization equipment. Another, technologies that have multiple purposes and indirectly aim at environmental protection are called “Light Green Technology”, including technologies designed for improving the quality of products, lowering the generation rate of wastes and reducing energy consumption.

Among these green technologies, clean coal technology deserves a close attention. Since China is a developing country that is rich in coal and poor in oil and natural gas, the clean coal technology is of significant meaning to the country. The clean coal technology consists of a set of specific technologies such as machining, combustion, transformation and emission control that could reduce pollutants emissions and improve utility efficiency in the whole process of coal exploitation and utility. This includes clean coal combustion technologies and technologies that transform coal to clean fuels. Now, the clean coal technologies are among the most advanced and mainstream technologies in the world considering that they could relieve the negative effects of coal exploitation on the environment. Many developed countries such as Japan and the U.S. have put forward a set of policies to promote the development and application of the clean coal technologies and have obtained remarkable achievements. Nonetheless, the characteristics of high investment and long return period never arouse enough motivation for the enterprises to spontaneously adapt the clean coal technologies. Under this situation, China should speed up the development and adaptation of

clean coal technologies and effectively employ the international technology platform. Meanwhile, by introducing advanced technologies abroad, the wide application of the clean coal technologies should be further promoted.

Green technologies are helpful for the construction of a resource-saving, high-efficiency and emission-reducing production system, and could control the human activities within the range that the environment is resilient. With the green technologies applied, the sustainable and harmonious development for both human society and the resource-environment can be actually realized. Many countries have paid attentions to environmental technologies regarding the research, development, application and export. The R&D of environmental technologies has been enhanced as well. In China, the construction of an environment-friendly production pattern could be fueled by the innovation of environment-friendly technology. Specifically, by independent innovation and gradient shift of international technologies, we should be focused on producing and adapting large-scale green technologies, therefore accelerating the transformation of economic growth mode.

Of course, the construction of an environment-friendly production pattern can not be realized in the short term. Instead, persistent efforts should be spent. We believe that, by incorporating economic, administrative and technology approach, we will be capable of achieving the strategic goal of constructing an environment-friendly production pattern, transforming economic growth mode in the future, and finally, ensuring the sustainable development of our society.



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