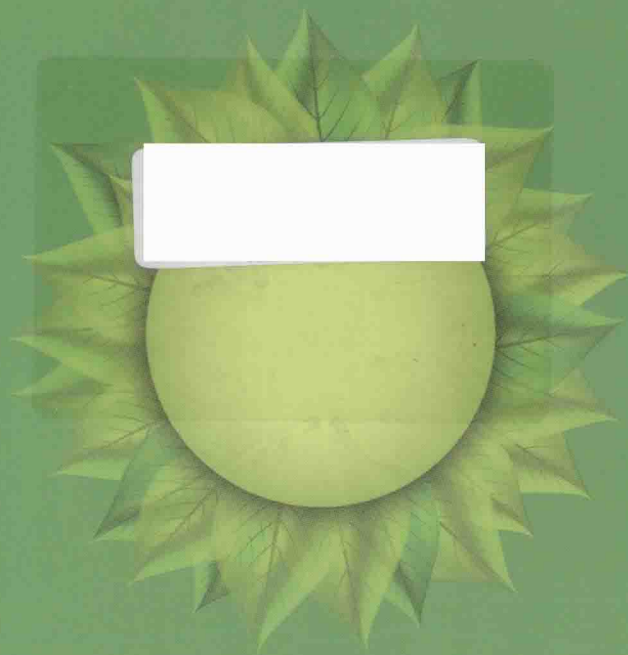





INNOVATION FOR GREEN GROWTH

Mu Rongping, Reinhard Meckl



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Introduction

With the challenges of a series of global issues, such as the global climate change and the financial crisis, how to make the transformation of economic development pattern become increasingly more important than ever. Therefore, green growth has drawn great attention from governments, academia and enterprises in recent years, while eco-innovation is recognized as a key to green growth. In order to facilitate knowledge sharing, joint learning and capacity building on the innovation policy for green growth, we coorganized the “4th Sino-German Conference on Technological Innovation and Management” at Institute of Policy and Management, Chinese Academy of Sciences from September 26-29, 2011 in Beijing.

This book “*Innovation for Green Growth*” mainly contains articles based on papers presented during the conference. The main objectives of the book are to deepen the dialogue, communication and cooperation among researchers from two countries, and to enhance knowledge transfer and exchange of information for green growth. The book consists of four parts, namely: (1) Innovative strategy for green growth; (2) Innovation policy for green growth; (3) Industrial innovation for green growth; (4) Enterprise technical innovation and future challenges for green growth. The articles in the book enhance policymakers’ and business leaders’ understanding of innovation policies for green growth and provide a platform for sharing policy experiences to facilitate implementation and improve efficacy of innovation policies for green growth.

The conference was financed by the “Sino-German Center for the Promotion of Sciences” in Beijing. We thank the center for the generous support and the help in organizing the conference. We also thank the center’s financial support for publishing this book. We also thank Dr. Song Hefa and Ms. Niu Ling for their support for and great effort in editing this book.

Mu Rongping, Reinhard Meckl
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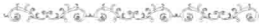
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Part 1

Innovation Strategy for Green Growth



Green Development and Innovation in China

Wang Yi

With its peaceful rising in international arena, China has become a major player in the process of global economic growth and sustainable development. In the context of globalization, the experiences got and challenges faced by China in its course of development are of global implications due to its large population and size of economy. Over the last sixty years, particularly over the past three decades, China has achieved outstanding results in its economic development. Even in 2009 against a backdrop of global financial and economic crisis, China's GDP still grew by over 8%, triggering another round of heated discussion on "the China Model". However, it should be noted that due to a number of factors (e. g. its specific development stage, national conditions, and international division of labor), China is confronted with a series of challenges in addressing such issues as poverty reduction, employment, population ageing, and, in particular, the negative impacts of resources and energy consumption and pollution on the global environment. For this reason, China is expected to play a crucial role in re-shaping the sustainable development worldwide, i. e. a green China is also needed (Friedman, 2008).

In addressing various challenges both at home and abroad and promoting sustainable development, China is trying to explore the way of sustainable development with Chinese characteristics. In recent years, based on our research, we have put forward the concepts that China has to achieve "sustainable rising" (CAS Sustainable Development Strategy Study Group, 2006); it should transform with a

sustainable development strategy under the new circumstances (CAS Sustainable Development Strategy Study Group, 2008); it should follow the path of low-carbon development with Chinese characteristics (CAS Sustainable Development Strategy Study Group, 2009); and green innovation and green transition will be key elements of the transformation of economic development pattern in China, Asian countries and the world (CAS Sustainable Development Strategy Study Group, 2010; CAS Sustainable Development Strategy Study Group, 2011; CAS Sustainable Development Strategy Study Group, 2012; AASA, 2011). All the conclusions were made on the basis of reviewing and reflecting the state of growth and environment over the last three decades, as well as the lessons and experiences learned in meeting various new challenges. These findings are expected to provide inspirations for the global community to develop green economy, ecologically-efficient economy and low-carbon economy under the context of financial crisis and climate change, and to offer guidance for China in its future reform and growth.

1.1 Three major challenges to China's sustainable development in the new era

1.1.1 Ongoing challenges of global financial crisis

Due to global financial and economic imbalances, in particular the long-term economic imbalance of developed economies, many countries in the world have been battered by the economic crisis that has never been seen over the last decades. To address this issue, many economies (both developed countries and developing countries including China) have launched financial stimulus packages in the effort to recover their economy at the earliest date possibly. So far, the global economy seems to have struggled out of the most difficult period and some countries have begun to recover, although the prospect of recovery is still uncertain and the recovery for the real economy is yet to be maintained. With the exit of stimulus policies and tightening of monetary policies, the world economy is still vulnerable to financial turmoil, and its long-term, sustainable growth is hard to be predicted.

What is unique for this crisis is that the financial crisis and global climate change have interwoven to complicate the issue, and addressing financial crisis has, to some extent, adversely affected the process of mitigating climate change. As a result, some experts and international organizations have recommended that all the major economies should integrate the short-term actions with long-term measures for

sustainable growth to achieve so-called *Green New Deal* and *Green Recovery* (Edenhofer et al., 2009; UNEP, 2009a; UNEP, 2008). In reality, no significant results have been made, and the existing industry structure and energy use remain little changed, which are quite different from the situation when the energy crisis took place in 1970s. In this case, if no effective measures are taken after the economic growth is re-launched, the demand for natural resources and energy and greenhouse gas emission may rise again.

China was also severely hit by the global financial crisis. Although China has achieved its target of “maintaining economic growth” through a series of measures, such as the economic stimulus package of 4 trillion yuan, the plan for invigorating ten major industries, as well as the action to develop new energy industry, some short-term economic problems have been transformed into long-term and local debts. New problems may emerge if the financial sustainability cannot be ensured. More importantly, while the economic stimulus package focuses more on traditional industries and large-sized state-owned enterprises, the new industries of strategic importance are far from being mature, the small- and medium-sized enterprises suffer from many difficulties, and China is still confronted with various structural conflicts. In addition, it has to address a number of issues such as the rising production costs, poor innovation capacity and the unsustainable extensive growth mode. Despite the fact that the Chinese central government has attached great importance to these problems, accelerating the structural reform and transforming the growth mode remain the most challenging task for China in the post-financial crisis era under the existing conditions and institutional framework.

1.1.2 Long-term challenges of climate change

No legally-bound agreement has been reached at the UN Summit on Climate Change in Copenhagen by the end of 2009. The prospect for UN Climate Change Conference which is held in Mexico in late 2010 is still gloomy amid many disagreements on funding, technology and equity. While the developing countries including China need to further defend their basic human right and development right, they should also make their due contributions to protecting the global climate under the principle of “common but differentiated responsibilities”.

Although more and more countries have recognized the importance of developing low-carbon economy, it should be noted that most of the wealth of developed countries is generated on the basis of relatively cheaper fossil energy sources. For the large economies, no best practices and models are available for them to expedite the

industrialization and urbanization drive by mainly depending on non-fossil energy sources, and to maintain high quality living standards under the scenario of low-carbon emission. Only defining an objective on transforming towards low-carbon development is far from being enough. It is also necessary for us to understand the pathway, constraints, technical tools and approaches, practical ways for international cooperation to achieve this objective, and who will bear the costs.

In the next decade, it is essential for China to explore the low-carbon pathway if it expects to achieve its goal of promoting industrialization and urbanization drive and addressing climate change. Although China does not have to commit any quantified emission reduction targets by 2020, and its per-capita energy consumption and emission is far lower than that of the developed countries, China, as the world's top carbon emitter, is bound to face increasing pressure from the international community. Under such context, China needs courage, wisdom and stamina to find an innovative pathway that is responsible and meets its actual conditions.

1.1.3 Challenges of a variety of domestic resources and environmental problems

As a large developing country, China's sustainable development is mostly threatened by the growing domestic resources and environmental problems. Against a backdrop of fast economic growth and upgraded consumption structure, the strategic energies (in particular the quality energy sources such as oil and gas) and the key mineral resources (e.g. iron, copper, aluminum and uranium) in China will be in tight supply in the long run. On the one hand, China's external dependence of the above-mentioned energies and resources is likely to grow further. On the other hand, China's overseas development of natural resources will be confronted with increasing constraints, posing a major risk to the energy and resource security in China. Therefore, it is imperative for the Chinese government to change its foreign economic cooperation strategy.

Compared with two decades ago, the existing eco-environmental problems in China have experienced significant changes, evidenced by more complex pollution pattern and the large area of ecological degradation. Due to the underlying causes of economic benefits-driven strategy, poor monitoring and supervision capacities, the overall environmental pollution in China has yet to be fully contained, which has extended into regional atmospheric pollution and river basin water pollution that are cross-sectoral and trans-administrative boundary. As a result, an integrated solution needs to be developed in no time. In addition, although a series of large-scale ecological programs have been implemented in China and some results have been

made, the ecosystems in the ecologically vulnerable central and western areas will face emerging pressures with the rising of the central regions and the advancing of western development program.

To simultaneously address various resources and environmental problems, the institutional arrangement and management matters more than technology and funding. It calls for the government to be accountable, shift its traditional ideas, coordinate different interests, innovate the institutions and mechanisms, and involve various stakeholders in the process. Only by integrating energy saving and environmental protection into the socio-economic activities can China fundamentally develop a comprehensive control framework and ultimately transform the environmental externality into the internal driving force of development for the country.

Challenges also herald opportunities. When the human society is shifting towards the post-financial crisis era, post-fossil fuel era and post-industrialization era, the global community is faced with a common problem: while meeting the challenge of financial crisis, how to explore new strategic opportunities, restructure the economic architecture and build new competitive advantages to address the aforementioned three challenges at minimum costs and with integrated and coordinated approaches. One solution behind these challenges is clear: green development and innovation.

1.2 What is green development?

To combat global financial crisis and climate change, the United Nations Environment Programme (UNEP) launched the initiative of *Global Green New Deal* and *Green Economy* in October 2008 (UNEP, 2008), released the policy brief on *Green New Deal* in March 2009 (UNEP, 2009a) and submitted the updated version on *Global Green New Deal* to G20 Summit in September 2009 (UNEP, 2009b). Its core concept is to “green” the economy by re-shaping and re-focusing on the policies, investment and expenditures of some key sectors, and to accelerate the pace to address climate change while working on economic recovery and jobs growth. Those sectors include: energy efficiency, renewable energy, green transport, green building, water service and management, sustainable agriculture and forestry, among others.

In June 2009, the Ministerial Council of the Organization for Economic Cooperation and Development (OECD) adopted the Declaration on Green Growth to encourage economic recovery through policy instruments and green investment in the short term, and help to build the environmentally friendly infrastructure required for a green economy, promote sustainable growth and shift towards sustainable, low-carbon

economy in the long term.

In October 2009, the European Council adopted the decision of developing “eco-efficient economy” under the post-Lisbon Agenda and EU sustainable development strategy. This indicates that in addition to advocating low-carbon economy, EU also proposed a longer-term and more inclusive eco-efficient economy, i. e. to build a safe, sustainable, low-carbon and energy-saving economy by transforming towards sustainable production and life style.

As a matter of fact, “green economy” is not a newly coined word, and no uniform definition has been provided. The concept of “green economy” can be traced back to 1960s when the US scholar Boulding put forward the idea of “spaceship earth economics” (Boulding, 1966), as well as the ideas of Daly and Pearce et al. on steady state economy, green economy and ecological economy since then (Daly et al., 2004; Pearce et al., 1989; Daly, 1973). In addition, many domestic and foreign scholars have addressed the topics related to the green development in China, including green economy, circular economy, low-carbon economy, and *Green New Deal* (Liu, 2001; UNDP China, 2002; Hu, 2004; Zhou, 2005; Zhuang, 2007; Zhu, 2008).

The connotation of green economy is constantly changing. Compared with the traditional development mode depending on fossil fuels, green growth or green economy is a new economic growth pattern that contributes to energy conservation and environmental protection. In China, all the discussions on green economy or green growth are focused on different aspects of sustainable development or the tasks at specific stages. They are aimed to achieve a win-win situation in economic development and environmental protection by shaking off the constraints of limited environmental carrying capacity and decoupling the economic growth and resources consumption.

Since the beginning of 21st century, China has been in a new development stage. At the same time, it is also confronted with a series of new problems. During the period of “11th Five-Year Plan” (2006 – 2010), China’s sustainable development was mainly focused on energy conservation, emission reduction and building a resources saving-based society. Under the new circumstances, China has to address growing challenges in sustainable development. As mentioned above, it has to tackle many domestic resources and environmental problems while having to meet the challenges of global climate change and international financial crisis; it has to focus on environmental protection while having to focus on socio-economic development; it has to “maintain the economic growth” while having to “adjust the economic structure”. In his speech at the opening ceremony of UN Summit on Climate Change at

Copenhagen by the end of 2009, former Chinese President Hu Jintao pointed out that China will “make great efforts to develop green economy, actively pursue low-carbon economy and circular economy, study and promote climate-friendly technologies”. This is a succinct summary by the Chinese top leaders on the ways ahead for China to tackle various challenges in the future (Hu, 2009).

For this reason, we have re-proposed developing green economy to achieve green growth in the new stage. This is done to realize three fundamental objectives: (1) giving top priority to solving the domestic resources and environmental problems; (2) leveraging technical progress to enhance the energy efficiency and green competitiveness, achieve green recovery, and address such issues as economic growth, poverty reduction and employment, among others; (3) shifting gradually from fossil fuels to new, low-carbon or carbon-free energies to develop energy conserving and environment-friendly industries, and to promote the “greening” of the economic system by means of transforming the growth mode, in particular the green transformation, with an ultimate goal of addressing long-term challenges in climate change and sustainable development.

The years between 2010 and 2020 are a key decade for China to accelerate its pace of industrialization and urbanization drive, and transform its development mode. By 2020, China is expected to fulfill its commitment of reducing carbon dioxide emission intensity and other indicators in addressing climate change, implement the *Circular Economy Promotion Law of the People's Republic of China*, and build a resources-saving, environment-friendly and low carbon-oriented society by constantly improving the efficiency of resources utilization and the environment quality. As a result, we believe it is necessary to integrate the development of green economy, low-carbon economy and circular economy into the framework of green growth, and highlight green growth as a key component of sustainable development strategy, in order to address the aforementioned three challenges. Great efforts should be made to accelerate the process of industrialization and urbanization through green transformation, and to explore a low-carbon growth mode with Chinese characteristics and achieve green revitalization and sustainable growth by building green industry, construction and transportation systems.

1.3 Promoting green growth needs to leverage green innovation

Innovation in all aspects is required to build a green China, achieve green transformation and follow a pathway of green growth. Meanwhile, the innovative

activities and their road map at the new stage have to fit into the needs of the actual situation in China, the global trend and green growth. Therefore, the innovative activities that are green-based and are aimed to address the above-mentioned three challenges are called green innovation or sustainable innovation. Achieving the goal of green growth calls for green innovation, which, in turn, can promote the green growth.

So far, innovation has become a core component of development strategy in each country worldwide, and green innovation will become a major trend in future innovation. In the next one and two decades, a new technological and industrial revolution that features green, intelligent and sustainable development is likely to take shape (Lu, 2009). "Green" could possibly serve as a key element in driving the new technological revolution and guiding the trend of innovation. This is a major challenge to China, as well as a historic opportunity for her to achieve sustainable development. We cannot afford to miss the opportunities offered by green innovation and the ensuing technological and industrial revolution.

Over the last thirty years, China's growth was mainly based on the extensive growth mode. In the next decade, China will undergo a process of transforming towards an innovation-based, intensive growth mode. Extensive growth mode is labor-intensive and at the cost of high consumption of resources and environmental degradation, with poor innovation capacity. In the future, external conditions of the extensive growth will experience some changes: (1) If the current population policy is still maintained, the working-age population in China will reach its peak within the next ten years, and the period of unlimited supply of labor is about to come to an end. (2) The resources and energy of strategic importance will be in tight supply, and the carrying capacity of environment will reach its limit. As a result, on the one hand, innovation has become an intrinsic factor for economic growth, while improving resources and environmental performance and achieving high-level development under the context of limited per-capita resources and carbon emission permits are defined to be a key indicator to measure the innovation capacity. On the other hand, against a backdrop of addressing financial crisis and growing external environmental pressures, it has become an inevitable option for China to adjust its economic structure, boost domestic demand, promote technological advancement and transform the development mode through innovation at all aspects. This will pose a major challenge to China for its green innovation in the days ahead.

At the same time, we have to note that new demands and markets are created for developing green economy and low-carbon economy in the course of addressing the

problems in environmental protection and climate change and meeting the challenges of financial crisis, which also provides new opportunities for green innovation. China's market demand for the solution of green technology is enormous (Kirkham et al., 2009), so is the global market demand for green innovation to mitigate climate change. Green innovation will not only benefit the general public, create new jobs and enhance the market competitiveness, but also build up the basis for China to be competitive in the global green market.

The enabling policy environment is needed for innovation and implementing a green growth strategy can drive the green innovation. Under the era of globalization, all the major countries worldwide are actively adjusting their strategies and policies in scientific and technological innovation, and promoting their development and enhancing their international competitiveness through innovation (China Innovation and Development of Chinese Academy of Sciences, 2010). The best practice in China during the period of "11th Five-Year Plan" (2006 – 2010) suggests that significant results have been achieved in terms of energy conservation, emission reduction and in addressing climate change. For example, some technologies, equipment and engineering construction in some areas (e. g. clean coal-fired power generation, renewable energy and high-speed railway) in the country have already reached world-class level, and even contain the core technologies developed by China. It is no doubt that as long as China follows the pathway of energy conservation and emission reduction and develops incentive policies to overcome the obstacles in market, financing and regulation, it will be ranked among the groups of top class worldwide in terms of energy conservation and emission reduction in the major industries in another one or two decades.

Innovation does not just mean technological innovation. It also involves institutional, policy and managerial innovation, and even cultural innovation. In the past, institutional innovation and managerial innovation were often regarded as the enabling conditions for technological innovation. Instead, they should be integrated as major components of innovation. In addition, green innovation is also a systematic process. Interaction, coordination, and cooperation are needed among different innovation activities in the open, competitive environment to reduce the risks of technological transformation, and ultimately to provide integrated solutions.

In his speech titled *Leading the Sustainable Development of China with Science and Technology* delivered to the scientific community in Beijing in November 2009, former Chinese Premier Wen Jiabao stressed that, to promote the all-round, coordinated and sustainable economic development of China in a longer-term basis, and follow the track of innovation-driven and endogenous growth, China needs to