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Environmental Protection and Sustainability Strategies in China: Towards a Green Economy

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Abstract

Due to its remarkable economic rise in the last three decades, China is now the world's second largest economic power. The country however has also become the world's largest greenhouse gases emitter and its growth continues to contribute to global and local environmental issues related to climate change, pollution, biodiversity loss and ecological deterioration. As China's industrialisation, urbanisation and agricultural modernisation persist, developing a green energy saving economy is becoming more important for the country and the world. This chapter examines China's major policies for environmental protection and current orientation towards a more sustainable development, including analysis of the relationship between GDP growth and carbon emissions. Sustainability strategies for policy makers are proposed to better direct the green growth path and achieve a secure clean energy future for an environmentally friendly society.

Introduction

With almost 20% of the global population, China is the world's most populous economy (US Census Bureau, 2013) and the OECD (2013) anticipates that China will soon surpass the US to become the most economically powerful country. This large country already holds many other top positions but not all of them are encouraging. Since 2006, China has been the largest global greenhouse gases (GHG) emitter (PBL, 2008) and in 2008 its total ecological footprint became 2.9 billion gha – the largest for a single country (WWF, 2012). Although on a per capita basis, these statistics look better, particularly in comparison with developed economies such as US and Australia, the impact of the Chinese economy on the globe is vast. However, China is now determined to become a significant player in tackling climate change and curbing environmental pollution. Since 2009, China has been the largest investor in new renewable energy technology (UNEP and Frankfurt School, 2013) and its current 12th five-year plan is promoting a resource efficient and environmentally friendly society.

The greening of the economy and transitioning to green growth should be at the heart of any development policies in the 21st century (OECD, 2013). This is also China's top national strategy on the road to sustainable development.

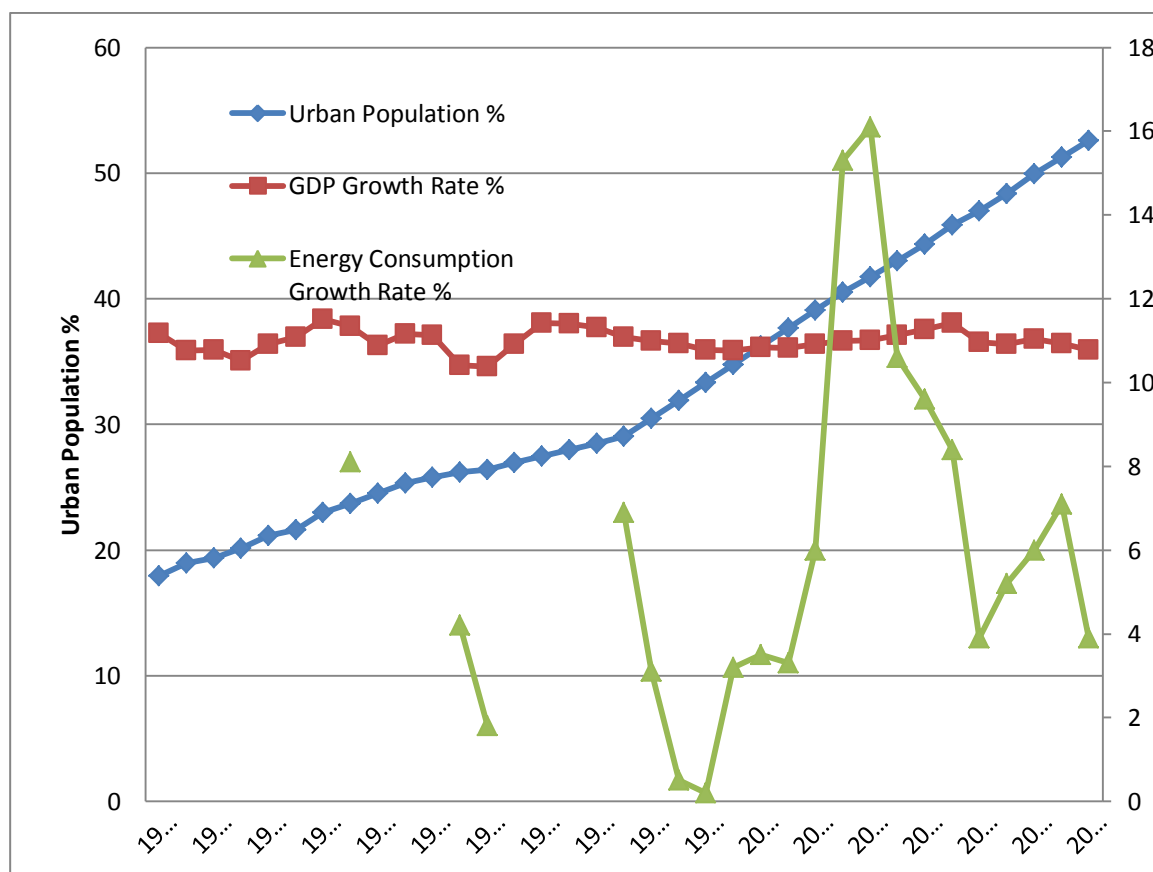
This chapter first examines China's dominant economic growth model associated with fast urbanisation, increasing energy demand and pollution. It then presents China's growing concerns about the issues relating to climate change, including growing carbon emissions and industrial environmental problems. Through exploring the current government policies aimed at pollution control, we examine China's new development model set towards a greener

economy. China’s policy shift in environmental protection is then analysed and sustainability strategies for a green transformation are put forward.

Economic growth and environmental issues in China

Since 1978 when China initiated its open door and economic reform policies, the country has achieved high average annual economic growth at a rate of about 11% (NBS, 2013). In 2012 the GDP growth rate was also high at 10.78% (NBS, 2013) but it is expected that 2013 will become a turning point in saying goodbye to double-digit growth rates. China’s economic growth was also accompanied by growing urbanisation (see Figure 1). The share of urban population increased sharply from 17.9% in 1978 to 52.6 % in 2012; thus more than half of the Chinese citizens now live in urban areas. Both, the intensifying industrialisation and fast increasing urbanisation drove China’s energy demand putting significant pressure on the country’s limited natural resources and raising severe environmental concerns.

Figure 1 Urban population %, GDP growth rate and energy consumption growth rate in China, 1987–2012



Source of data: NBS (2013)

Environmental issues

Fossil fuels (coal, oil and natural gas) provide the basis for satisfying China’s ever-growing energy need (see Table 1); however the energy mix has changed since 1978. Over the last 35

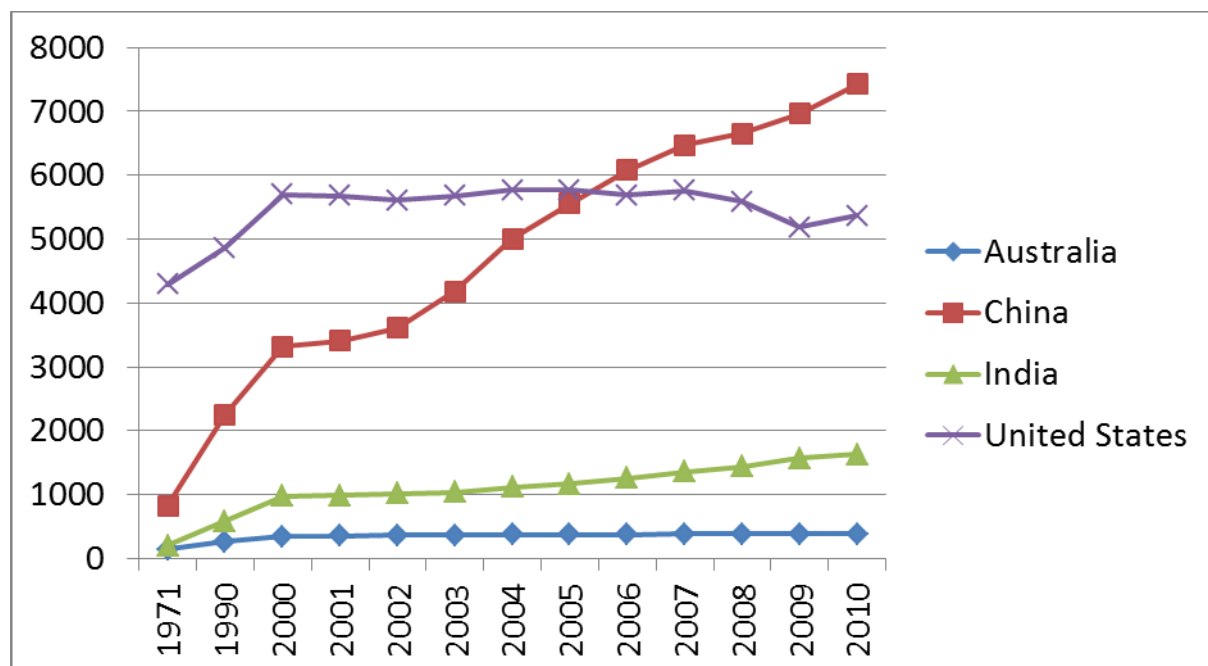
years, the dependence on coal increased due to the ample availability of this resource, despite the overall decrease in the reliance on fossil fuels (from 96.9% in 1978 to 89.9%) (NBS, 2013).

Table 1 Energy Mix in China 1978–2012

	Coal	Oil	Natural gas	Hydro/Nuclear/Wind
1978	70.3	23.7	2.9	3.1
1990	74.2	19	2.0	4.3
2012	76.6	8.9	4.4	10.1

Source: NBS (2013)

Figure 2 CO2 Emissions from Fuel Combustion, 1971-2010 (million tonnes) (GHG)



Source of data: OECD (2013b)

China's rapid GDP growth over the last three decades has caused serious airborne pollution in many cities and rural regional areas (Wei et al., 2012). In particular, the use of coal as well as other fossil fuels for energy supply is a serious environmental problem due to the associated high CO₂ (or carbon) emissions as well as air pollution. China is the leading carbon emitter (see Figure 2) with an annual generation of more than 7.5 billion tonnes of carbon dioxide emissions stemming from the burning of fossil fuels and the manufacture of cement (World Bank, 2013). Although on a per capita basis, China is ranked 61st of 197

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countries and way behind Australia (9th) and US (10th) (World Bank, 2013), the sheer volume of carbon poses a severe environmental threat.

China's heavy reliance on coal is also responsible for a large amount of particles released in the atmosphere. This situation is further aggravated with the pollution caused by the increasing number of commercial and private vehicles on the road. In January 2013, the observed intensity of PM_{2.5} (airborne particles smaller than 2.5 micrometres) in Beijing's air reached the scale's maximum pollution level of 500 micrograms per cubic metre (Mu, 2013). The PM_{2.5} particles are harmful to human health, particularly for China's burgeoning ageing population, and the World Health Organisation recommends the 24-hour exposure to PM_{2.5} to be no higher than 25 (South China Morning Post, 2013). It was reported that the number of patients with respiratory illnesses sharply increased; some schools had to cancel their outdoor sports activities, and the wellbeing of city residents were jeopardised by the heavy smog. These particles are a major health hazard that can trigger cardiovascular and respiratory diseases (Chen, 2012). They are responsible for a significant reduction in average life expectancies, premature deaths, additional hospital admissions, increased use of medication and millions of days every year where human activities are restricted (CEC, 2005). Consequently, news about Beijing's air pollution were widely reported domestically and globally. The Chinese capital is just one of the many cities suffering from potent air pollution due to the country's increasing industrialisation. Other cities affected include Shanghai, Guangzhou and Tianjin.

Recently, the Chinese public started to voice its concerns that people are paying for economic growth with their health (Economy, 2004). China's oldest and highly influential non-governmental organisation (NGO), Friends of Nature, has been playing a significant role in air pollution reduction. The serious concerns about PM_{2.5} raised by the public and this NGO have pushed authorities to amend the country's air quality standards (Chen, 2012).

Other contaminants, such as the emissions of nitrogen-containing pollutants from agriculture, transport and industry, have also increased by over 50% in 30 years, leading to further environmental deterioration in China (Qiu, 2013). Nitrogen emissions are very harmful to China's ecosystems, causing soil acidification, fertilising harmful algal blooms and threatening biodiversity. Once they are emitted into the air, key nitrogen pollutants of ammonia and nitrogen oxides can be transformed to secondary pollutants such as ammonium and nitrates, and they are then washed to Earth by rain and snow. This process is called nitrogen deposition (Narayanan and ClimateWire, 2013) and one of its by-products, namely nitrous oxide, has a 300 times greater global warming potential than carbon dioxide (Smith, 2010). Although the use of synthetic nitrogen fertilisers is the main source of this pollution, the contribution of industry and transport is growing fast.

With more residents becoming knowledgeable and participating in environmental protection activities, the public is becoming a powerful force in influencing China's environmental protection. According to Friends of Nature (2012 and 2013), people have started to gradually understand their right to be involved and demand improvements in the government's decision-making efficiency in relation to air quality and pollution. This has triggered a range of important positive changes.

Enterprises strictly monitored for pollution and information disclosure

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In 2008 and 2013, the Ministry of Environmental Protection of China published the names of enterprises which needed extensive supervision for pollution. These enterprises were encouraged to standardise their self-monitoring processes and provide information disclosure in relation to their operations. They were also urged to meet the regulatory obligations with respect to environmental protection, take on social responsibilities and encourage public participation (Ministry of Environmental Protection of the PRC, 2013).

The self-monitoring entails these enterprises to undertake environmental monitoring activities according to existing environmental protection laws and regulations for the purpose of understanding their waste discharge situation and the ensuing impact on surrounding areas. They need to monitor discharged water pollutants, airborne pollutants and noise pollution, report and guarantee environmental quality according to their environmental impact assessment form. In 2008, the environmental authorities identified 3472 enterprises as requiring strict monitoring for airborne pollution due to their heavy industrial wastes and negative impacts on agricultural land. The new list includes “more than 15,000 enterprises that discharge wastewater and gas, sewage treatment plants, heavy metal enterprises, and livestock and poultry farms” to be under state monitoring (Anon., 2013: n.p.).

With the introduction of environmental information disclosure in 2008 (Zhang et al., 2010), there was urgent need to standardise China’s environmental laws and regulations. However, the best way to solve the environmental pollution problem was to strengthen administrative accountability. This meant that Chinese government officials from administrative organs were made responsible and consequently penalised for corruption or if they acted as an “umbrella” to protect those who continued with illegal discharge of waste into the environment. Local governments in particular are now expected to undertake full administrative accountability for environmental protection, including for enterprises that break environmental laws and regulations and need to face serious punishment and penalties (Xinhuanet, 2013c). The strictly monitored enterprises are part of the responsibility of local governments and environmental accountability is seen as the key to pollution control.

For a long period of time local governments’ performance was assessed primarily on GDP growth and making local leaders accountable for environmental pollution is a major change in direction by the central government. Their achievements are now assessed not only on pursuing economic growth but also on their environmental performance. Local governments are now acting as environmental watchdogs and regulators who have power to punish cities and enterprises for environmental pollution and they regularly release black list of cities and industrial enterprises that are penalised for failing to properly treat pollution discharges (Chen, 2012).

Information disclosure is becoming an important method for pollution control and encourages enterprises to take more environmental responsibilities. In 2008, according to their emissions of SO₂ and NO_x, China’s over 80 thousands enterprises were ranked by the Ministry of Environmental Protection, which named 3472 enterprises of them as requiring to be strictly monitored for airborne pollution because their industrial emissions contributed 65% of the

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total industrial pollution (Wei et al., 2012). With 2069 or almost 60% of the listed enterprises located in 899 counties of China, the contamination from these industries was having negative economic impacts causing agricultural loss due to airborne and other pollutants. For example, in spite of the ground-level ozone, the emissions of SO₂ by the strictly monitored enterprises reached 17.05 million tonnes in 2011, accounting for 84% of total industrial SO₂ emissions (NBS, 2011).

In 2013, the list of strictly monitored enterprises was updated by the Ministry of Environmental Protection and became longer indicating that overall the number of big polluters has decreased. It comprises over 15 thousand enterprises to be strictly monitored for waste pollution, including 4944 enterprises monitored for waste water discharge, 4189 enterprises monitored for waste gases, 3581 enterprises supervised for dirty water discharge, 2834 enterprises for heavy metal discharges and 249 livestock and poultry farms (Ministry of Environmental Protection of the PRC, 2013).

There is a lot of publicity given to the performance of these enterprises. For example, the Guangzhou Municipal Environmental Protection Bureau published in the media the names of 67 strictly monitored enterprises and required them to disclose their data on pollutants. The list includes 18 enterprises monitored for waste gases, 28 for waste water and 21 for heavy metal, such as Guangzhou Petrol-chemical Factory, Guangzhou Steel and Iron Factory, Zhujiang Beer and nine other large electricity generating factories which are the main sources of major pollutants (Ifeng, 2013). For example, the Guangzhou Petrol-chemical Factory emitted over 40% of the volatile organics compounds (VOCs), the main source of smog formation in the city. The power generating factories dominate the Guangzhou list emitting 20% of the PM_{2.5}. Through strengthening and increasing the frequency of field investigations and supervising the environmental protection work, the listed monitored enterprises are requested to enhance their monitoring system building. They were also asked to report their data to the relevant environmental authorities on a regular basis and report the measures taken. Eventually they were pushed to accept public supervision through online reporting of pollutants data (Ifeng, 2013) while bearing the costs for any new technology and devices as well as for the conducting of the self-monitoring tasks (Xinhuanet, 2013).

Despite the many measures put in place across many regions, pollution compliance continues to be a serious problem in China. The Ministry of Public Security and the Environmental Protection Bureau are actively persecuting offenders who illegally discharge poisonous and other pollutants, including those who do this indirectly through agents in order to reduce their waste processing costs (Xinhuanet, 2013a).

Water pollution is also becoming a serious environmental problem. A constant monitoring survey for 118 Chinese cities shows that 64% of their underground water was severely polluted, 33% was slightly polluted and only 3% of the underground water is basically clean (Xinhuanet, 2013b). Meanwhile, 88 enterprises from six northern provinces were fined over ¥6 million for illegal pollutant discharge (Xinhuanet, 2013b).

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Economic expansion causing growth in the consumption of fossil fuels is triggering increasing levels of emissions of sulphur oxides (SO_x), nitrogen oxides (NO_x), carbon dioxide, soot and fine particulates (Wang et al., 2007). China's industry and agricultural sectors are also contributing to environmental deterioration. Among serious concerns voiced by the public, the government started to put in place initiatives that attempt to control and curb pollution. Despite many challenges, China is slowly shifting on a path to improve its environmental record and develop a greener economy.

Greening the economy in China

China's sustained economic growth contributed to fast industrialisation, urbanisation and improvements in the living standards of millions of people. The government achieved enormous success in alleviating poverty. Official estimates indicate that between 1978 and 2010 the incidence of rural poverty fell from over 30% to only about 3%, and the size of rural population living in poverty decreased from around 250 million to 27 million (Household Survey, 2011). This however has come at a price for the country's natural environment and the global ecology.

According to the Global Footprint Network (2013) assessment, China is operating in a state of biocapacity deficit as its per capita ecological footprint is 2.5 times the available per capita biocapacity in the country. It is also bigger than the global per capita biocapacity and has been on a steady rising trend in the last ten years (WWF, 2012). The growth in the total ecological footprint is triggered by the increasing total consumption of resources with the carbon footprint being the most rapidly expanding component (WWF, 2012).

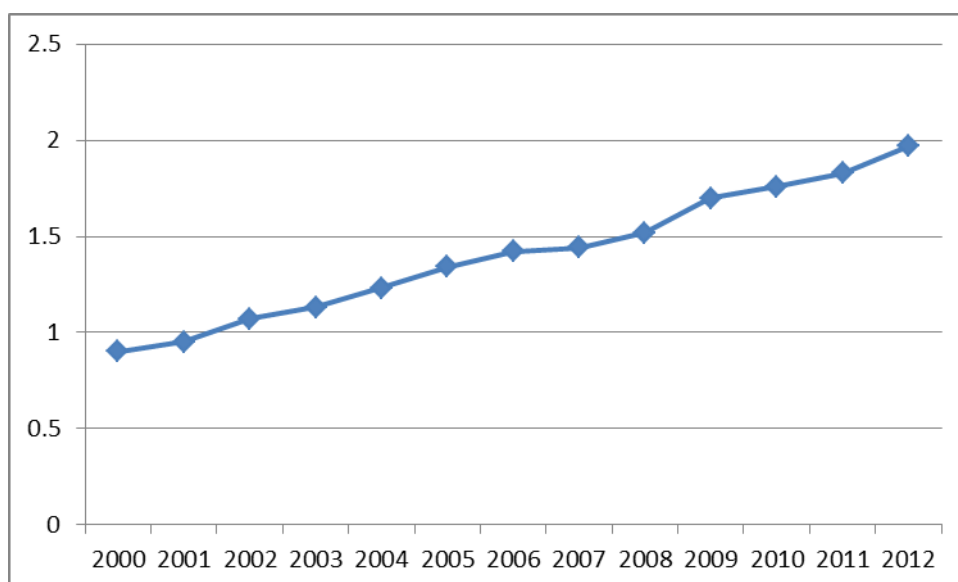
The need for a change in this development pattern is recognised by the Chinese government which is determined to put the country's economy on a green path. Since 1989, when the green economy concept was first put forward by Pearce (Pearce et al., 1989), many countries are taking actions in this direction. According to UNEP (2013: 31), a green economy is "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities." Such "transition to a green economy not only generates increases in wealth, in particular a gain in ecological commons or natural capital, but also, over a period of six years, produces a higher rate of GDP growth" (UNEP, 2013: 32).

An evolving green economy helps improve ecosystem health and maintain its functionality and this is what China is set to achieve. It is expected that developing a green economy can put a brake on China's environmental deterioration. This economy is characterised by resource efficiency and environmentally friendly society as outlined in China's current 12th five-year plan. The extensive development model characterised with high consumption of energy and raw materials, high pollution and GHG emissions needs to be transformed into a low-carbon and circular economy (centred around reduction, recycling, reusing and rethinking) which aims at reconciling the contradiction between limited natural resources and what appears to be unlimited human demand (Shen, 2010). This involves green

industrialisation and high technology industries with innovation playing a substantial and decisive role (Marinova et al., 2013).

This process of transformation comes with both challenges and opportunities. There is urgent need to look for solutions at a rate faster than the rate of environmental degradation (UNEP, 2013) while continuing to improve people’s wellbeing. To achieve this, both private companies and governments are investing in innovation. Real growth spending on R&D in China has exceeded 18% since 2000 with the aim to reach 2.2% of GDP by 2015 (McLean-Dreyfus and Bendemra, 2012). Investment in R&D is on an upward trend (see Figure 3) and in 2012, 47 Chinese companies were in the top global 1000 largest R&D investors (Jaruzelski et al., 2012). In 2011, China became the world’s top nation for domestic patent applications – surpassing both Japan and the United States. Its 12th five-year plan (2011-2015) sets the target of transforming China into an innovation-oriented society by 2020 and the evidence shows that this is already happening.

Figure 3 R&D Intensity (the ratio of R&D expenditure over GDP), China 2000-2012



Source of data: National Bureau of Statistics of China

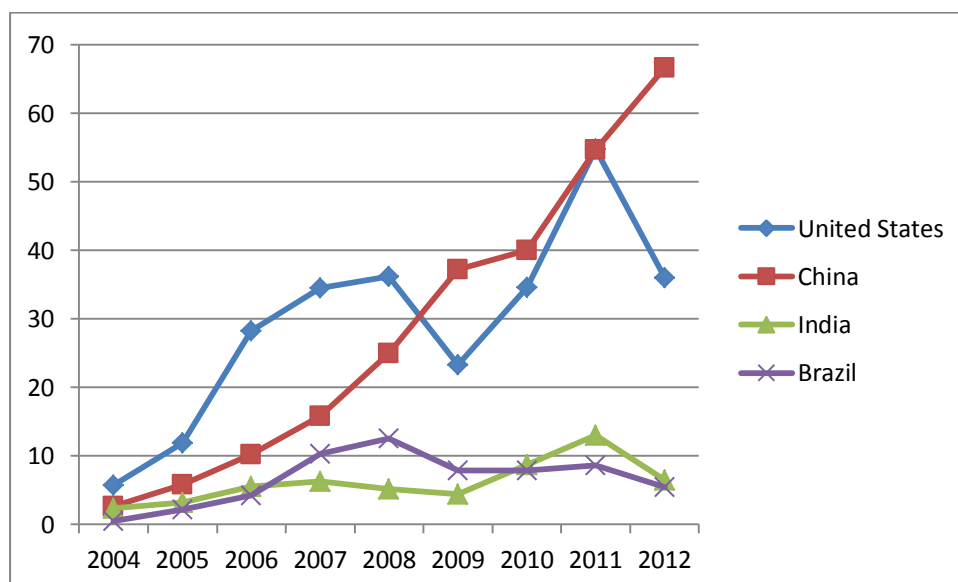
China is performing extremely well in the area of renewable energy. After announcing in Copenhagen in 2009 a voluntary commitment to cur carbon dioxide emissions per unit of GDP by 40-45% by 2020 compared with the 2005 levels, its 12th five-year plan sets the target of 17% reduction by 2015

China announced to cut voluntarily its emissions of carbon dioxide per unit of GDP by 40 to 45% to 2020 compared with 2005 levels. Between 1990 and 2005 China reduced its carbon intensity by 44 % (40-45% reduction by 2020 in Copenhagen; 17% reduction in China’s current 12th Five-year Plan by 2015). In 2009, China overtook US in total installed energy capacity and new investment in renewable energy (see Figure 4); in 2013 it is the top renewables investor followed by Germany, US and India (UNEP and Frankfurt School, 2013).

China also ranks 3rd (after France and Japan) according to the low-carbon competitive index (The Climate Institute, 2013). With commitments increasing by 22% to \$67 billion, mainly due to solar investment, China now hosts 27% of the global renewable energy total (UNEP and Frankfurt School, 2013).

The concentration of clean energy, the flagship of the green economy, has now turned into Asia, particularly in China, Japan and South Korean through high technology exports and the large amount of public investment in the clean energy field (The Climate Institute/GE, 2013). In the transition to a green economy, the new jobs created over time exceed the losses in brown economy employment. This is the case with China where new jobs are constantly created (Pan et al., 2011). Achieving this net gain, however, requires investment in re-skilling and re-educating the workforce where China also excels. According to the International Labor Organisation (ILO, 2013), the pursuit of a green economy will not cut employment opportunities overall, on the contrary, it will generate more and decent jobs. In China, with proper strategies, this change will help reduce the environmental and resource pressure from economic development and create employment opportunities in enterprises that are more environmentally friendly, enhance innovation and attract investment). According to the Worldwatch Institute (2013), it is expected that China's fast growing economy would create millions of new green jobs over the next eight years. China's energy, transportation and forestry sectors alone could provide at least 4.5 million green jobs by 2020 (Worldwatch Institute, 2013).

Figure 4 Trends in renewable energy investment 2004 – 2012 (\$bn)



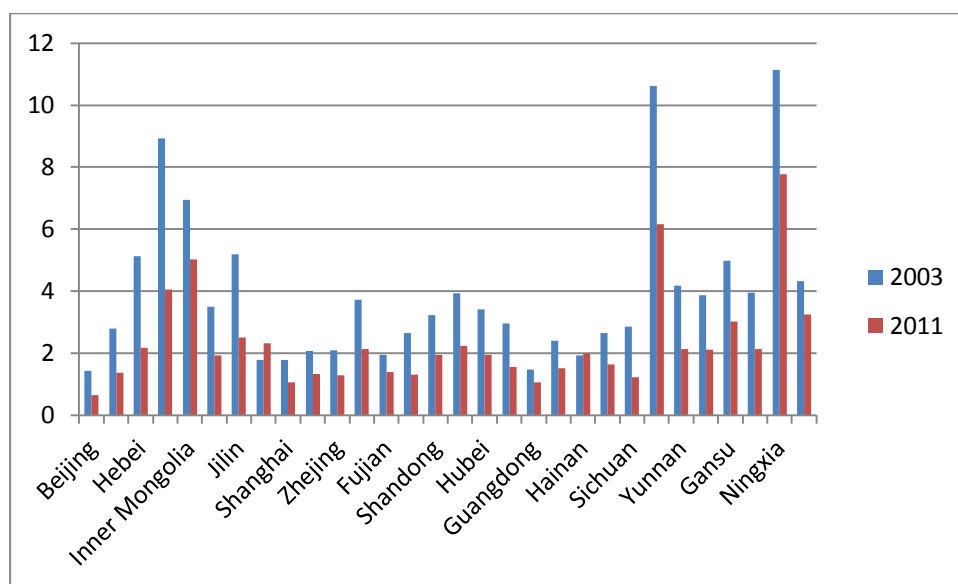
Source of data: UNEP and Frankfurt School, 2013

There is already evidence that the transition to a green economy is contributing towards reducing GHG emissions. Figure 5 compares China's provincial CO₂ emission intensities in 2003 and 2011. The trends show that all provincial CO₂ emissions per capita GDP dropped considerably at various levels (Jia et al., 2013). The central and western regions had overall

higher annual decrease rates, which illustrates that the traditional regional disparity between the East and the rest of the country is gradually reducing as a result from the green economy.

China's national innovation system has been progressively enhanced by new knowledge, green technologies and growing R&D investment. The country is evolving as a significant player in addressing global warming and tackling pollution which stimulate its transformation towards a green economy. As part of the emerging global green system of innovation (Marinova et al., 2013), China is now an important global player in green innovations.

Figure 5 CO2 Emission Intensities of China's Provinces in 2003 and 2011



Source of data: National Bureau of Statistics of China

Factors influencing the transformation to a green economy

There are many factors which assist the smooth transition to a green economy in China. However, government accountability, environmental education, public participation and environmental regulation play a major key role in this process and we briefly examine them below.

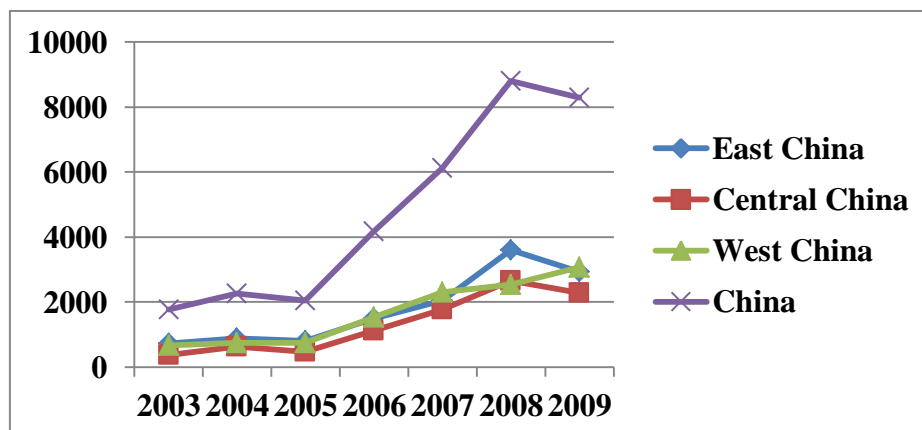
Although environmental accountability has long been established, it has not been easy for all levels of governments to properly implement these regulations due to the adrift between power and responsibility of local governments. Often faced with environmental incidents, relevant local governments avoid their responsibilities (China Environment, 2012). A more mature mechanism needs to be put in place with strengthened supervision to allow local authorities to have more evidence and power to undertake accountability. Being China's major accountability body, the National People's should also have accountability power for receiving information, interpellation and investigation. The move to include environmental

protection indicators in the performance evaluation of local leaders is a step in the right direction. Further, there is urgent need to establish the responsibility mechanism for the overall planning, coordination and collaboration between local governments for environmental accountability. The full power of the law needs to be enforced on enterprises' environmental behaviour and encourage those who take environmental responsibilities.

Environmental publicity and education is another area that can facilitate green growth. Environmental educational programs, such as the 1996-2010 National Environmental Publicity and Education program, should become a permanent feature to enhance the nation's environmental awareness and educate citizens to protect the natural resources. Enhancing a higher level of public environmental consciousness is vital for achieving China's transformation to a green economy within an energy efficient and environmentally friendly society. Such Environmental Education Programs need to be carried out in adult education, mass media and through activities targeting business people, governmental agencies and pollution producers. China's effort to promote environmental protection will be gradually increasing people's environmental consciousness. Environmental training programmes, including developing of a low-carbon economy, should be delivered to environmental experts, scientific, technological and managerial personnel in order to decouple economic growth from environmental pressure.

The mass media play an important role for increasing environmental awareness and particularly the newspapers owned by the governments have been performing this role increasingly better. They not only trigger public concern for environmental damages but also strongly create public consciousness. After an incident of environmental damage is disclosed in the media, this generates a lot of public opinion pressure on the polluter as well as on the local government to which they have to respond by taking appropriate measures. A positive environmental publicity on the other hand plays a significant role in public environmental education and guidance. The topic of environmental protection has increasingly been covered by media reports in all the provincial newspapers (see Figure 6) which contributes to environmental publicity, supervision and disclosure of environmental incidents.

Figure 6 News/Articles Related to Environmental Protection in Provincial Newspapers in China, 2003–2009



Source: Guo and Marinova (2010)

China non-governmental organisations have also contributed in improving environmental awareness and behaviours. For example, Green Peace and Friends of Nature have helped push the green transformation; people's congress started to discuss and undertake laws and regulations to control environmental pollution and China has added several environmental laws and regulations in the 12th five-year plan. The environmental management mechanism in China has generally improved to prevent more polluting incidents happening. For example, in recent years, the number of environmental petitions and proposals submitted to the National People's Congress (NPC) and the Committee of the Chinese People's Political Consultative Conference (CPPCC) has been steadily growing, indicating that the level of the public participation and consciousness in environmental protection is on the rise (Guo and Marinova, 2010).

China significant effort in battling pollution – more than ¥3 trillion were recently allocated by the Chinese government to improve air and water quality in the next five years (Zhi, 2013) with ¥1.7 trillion to be used for airborne pollution (Wee, 2013), would not be achieved without strengthening and improving China's environmental laws and regulations. Current regulations and plans for this transformation are covered in Table 1. The country's environmental protection industries are expecting a golden period with many opportunities to improve key technologies and the provision of environment protection device and services (Xinhuanet, 2013d).

Table 1 China's laws and regulations facilitating a green economy

China's laws and regulations relating to green economy

- Environmental protection law of the People's Republic of China (PRC)
- Water pollution prevention law of the PRC
- Total amount of main pollutants emission reduction, monitoring and assessment solutions covered in the 12th five-year plan (FYP)
 - Environmental monitoring and management solutions
 - Energy efficient and environmentally friendly society
 - Administrative accountability for the environment

Seven strategic emerging industries in the 12th FYP

- 1 New energy auto industry
- 2 Energy-saving and environmental protection industry
- 3 New generation information technology industry
- 4 Biology industry
- 5 High-end equipment manufacturing industry

6 New energy industry

7 New material industry

Targets covered in the 12th FYP

- Reduce the energy-intensity of the economy by 16% and increase non-fossil energy to 11.4% of total supply
- Cut the carbon-intensity of GDP by 17%
- Slower energy demand growth

China's first regulation of accountability for the environment was implemented in 2006. Its objective of building a resource efficient, environmentally friendly and harmonious society represents the whole spectrum of the sustainability goals.

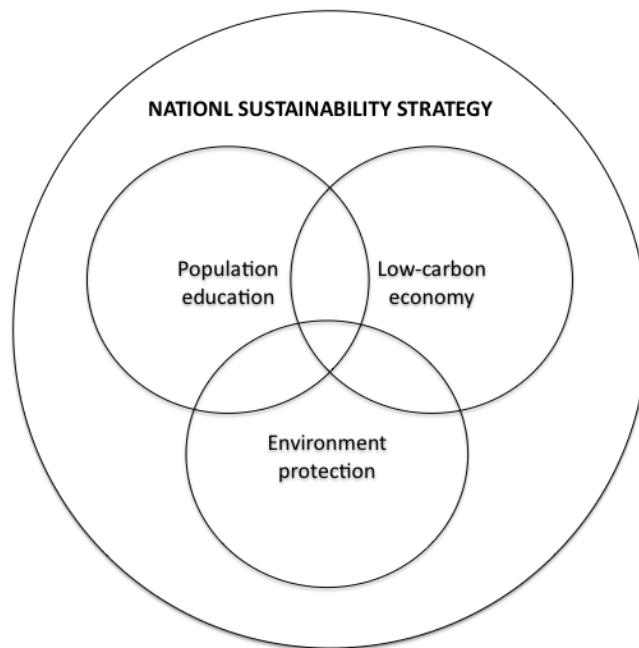
Conclusion

This chapter analysed China's environmental transformation and its path towards a green economy where balanced, mutually supportive and reinforcing relationships exist between economic development and the natural environment (Green Economy Taskforce, 2011).

China's astonishing economic rise in the last three decades has attracted a lot of global attention. However, the country is also criticised for its environmental deterioration, particularly for emitting the largest amount of carbon dioxide relating to global warming. As the world's largest country, China's development trajectory is vital to the global achievement of sustainability. Although the environmental awareness of the Chinese people has been significantly improved and the country is shifting towards greener technologies, there is a long way to go for China to transform itself from the current economic model to a green economy. Its growing investment in R&D, renewable energy and sustainable technology innovation is making the country to emerge as a green energy leader and helps decarbonise its economy.

Building a resource efficient and environmentally society is a long-term strategy and it is challenging for China to balance between the basic sustainability goals of developing a green economy, improving ecological protection and improving people's education (see Figure 7). China's government policy is shifting to these goals with the understanding that GDP growth is beneficial to many people, but all Chinese people will benefit from a good environment in a harmonious society. Building an energy-efficient and environmentally friendly society is very important for China's transition to a green economy. Committing to improving the quality of economic growth which the green economy represents, is a prerequisite to maintain the long-term, steady and relatively fast growth of the Chinese economy.

Figure 7 China's national sustainability strategy



Source: Guo et al. (2013)

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