



Promoting green ICT in China: A framework based on innovation system approaches

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ABSTRACT

Green ICT is a key enabler of a green economy. To aid policy makers in promoting green ICT at the national level, this paper proposes a comprehensive understanding of green ICT from the perspective of green innovation and develops an analytical framework based on innovation system approaches. Following the framework, policy makers can identify the critical system failures of a green ICT innovation system by assessing the key structural components of the system and, hence, formulate policies to solve them. The framework is used to analyze the green ICT innovation system in China. The findings indicate several critical system failures that hamper the development and diffusion of green ICT in China. Accordingly, policies are suggested to address the failures. This paper aids in the understanding of green ICT and contributes to the development of systematic approaches to formulating green ICT strategies. The Chinese experiences provide practical implications, which can be considered by other countries for reference.

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1. Introduction

Economic recovery and sustainable development are key challenges that all countries now face. The global economic crisis and the rising alarm on energy issues and climate change make it increasingly urgent to pursue a change in the growth pattern of the world economy. Under such circumstances, the idea of green economy has emerged as a solution to both environmental and economic problems and moved into the mainstream of policy discourse (Organisation for Economic Co-operation and Development (OECD), 2009a; United Nations Environment Programme (UNEP), 2009, 2011). A green economy is defined as one that results in improved human well-being and social equality while significantly reducing environmental risks and ecological scarcities (UNEP, 2011). It is compatible with the older concept of sustainable development,¹ but with a greater focus on achieving environmental sustainability and economic growth simultaneously. A green economy not only subjects economic activities to strict environmental requirements but also provides significant opportunities for growth in wealth and jobs, with the growth driven by investments that improve environmental performance. With this understanding, many national leaders have high expectations of the green stimulus and are attempting to turn the green economy vision into reality (The Green Growth Race, 2009).

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¹ A simple definition of sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development (WCED), 1987). It is an eclectic concept, as a wide array of views fall under its umbrella. Economic development, social development and environmental protection are typically considered as three interdependent pillars of sustainable development (United Nations (UN), 2002).

In creating a green economy, the information and communication technology (ICT) industry has been identified as one of the key driving sectors. Based on many studies on the environmental impacts of ICT, ICT has been considered part of the global environmental problem but is also part of the solution (for example, [International Telecommunication Union \(ITU\), 2009](#); [OECD, 2010](#)). Accordingly green ICT, as a concept that aims to eliminate ICT-related environmental problems and drive positive externalities, is embraced by both the ICT industry and national policy makers. Governments and businesses worldwide have launched a wide range of initiatives and programs to implement green ICT ([Asia-Pacific Telecommunity \(APT\), 2011](#); [Organisation for Economic Co-operation and Development, 2009b](#)). The ICT industry regards green ICT as an emerging opportunity that would create a large market in the future ([Gartner Research \(Gartner\), 2008](#); [Gartner Research \(Gartner\) & World Wide Fund for Nature \(WWF\), 2008, 2010](#)). For national policy makers, green ICT can make economic processes and human activities more carbon-effective while stimulating growth ([Fernando & Okuda, 2009](#); [World Economic Forum, 2009](#)). Therefore, at the national level, green ICT has become a new policy area and has been included in the national strategies of many countries/regions including both developed and developing economies ([Asia-Pacific Telecommunity, 2011](#); [Organisation for Economic Co-operation and Development, 2009b](#)).

China is among the countries that are preparing to implement green ICT. The large but less-developed country is in a historic period for transforming its mode of growth and restructuring the economy. China's rapid development, with an average growth rate of over 9% in GDP in the past three decades ([National Bureau of Statistics of China \(NBSC\), 2011a](#)), has attracted worldwide attention. However, as China's economy continues to grow, its contributions to global warming and other environmental problems also increase. China became the world's largest emitter of greenhouse gas in 2006 when it contributed 20% of the global emissions, and the proportion increased to 25% in 2010 ([Energy-ol, 2011](#)). The energy efficiency of Chinese industries is poor. Although it improved 19% during the period of 2006–2010, the energy consumption per unit GDP remains over twice as much as the world average ([NBSC, 2011b](#)). Moreover, as the most populous country in the world, China suffers heavily from shortages of land, water, forest, and mineral resources in per-capita terms ([The World Bank, 2007](#)). The rapid economic growth, to a great extent, has been achieved at the expense of the over-exploitation of resources and environmental pollution. The increasingly reported environmental problems, such as soil erosion, desertification, air and water pollution, and the increasing number of endangered species, have caused large economic losses and seriously damaged public health ([The World Bank, 2007](#)). From a global perspective, China has become the largest source of pollution threatening the ecosystem of the planet ([Grano, 2008](#)). Under pressure from the international community and with consideration of its own prosperity, it is imperative for China to place green growth at the heart of its economic strategies. Energy efficiency and emission reduction has become a keyword of China's policies since 2009, when it made a commitment to the world that by 2020, its CO₂ emissions per unit of GDP will be reduced by 40–45% from 2005 levels. In its 12th Five Year Plan (FYP), China has signaled its intention to shift from a policy of maximizing growth to balancing growth with social harmony and environmental sustainability ([The Climate Group, 2011](#)). The key measures to realize such a shift and achieve the emission reduction objectives include the following ([The Climate Group, 2011](#); [The PRC State Council, 2011](#)):

- Enforcing regulations and legislations for low-carbon economy and environmental protection.
- Upgrading traditional industries by promoting the convergence between ICT applications and industrialization.
- Investing in new energy sources and other energy-efficient technologies while reducing the use of fossil fuels.
- Increasing the contribution of service industries and strategic emerging industries (SEIs) to economy.
- Launching key projects in energy-saving, disposal of pollutants, and resources recycling.
- Improving energy-efficiency in mining, manufacturing, building, transportation, agriculture, and public service sectors.
- Introducing fiscal reform measures that use taxation and pricing in pursuit of environmental and energy goals.

The ICT industry is one important part of the measures above ([Hong, 2011](#)). First, next generation information technology is one of the seven SEIs in the 12th FYP, which indicates that the growth of the ICT industry is critical to China's economic restructuring. Second, ICT application is considered as a powerful promoter in upgrading traditional industries. Third, ICT is an essential technology in improving the energy efficiency of many economic sectors. Finally, ICT provides effective technical supports for environmental monitoring, natural resource management and emission assessment. Thus, ICT should be converted to green ICT to achieve the environmental sustainability objectives.

In addition, green ICT means a great opportunity for the ICT industry of China. Today, China tops the world in terms of the user scale of ICT products. However, its ICT industry lags behind in terms of technological innovation ([Gao & Liu, 2012](#); [Kshetri, Palvia, & Dai, 2011](#); [Zhang & Liang, 2009](#)). Lack of domestically developed core technologies greatly weakens the competitiveness of Chinese ICT firms in the global market. As one of the SEIs, which are expected to become pillar industries in the economy and international leaders by 2030 ([The Climate Group, 2011](#)), the ICT industry of China must catch up or even leapfrog in the world technological race. Green ICT, as a group of new technologies, products, services and applications, provides a historic opportunity for such a leap.

In sum, green ICT is significant to China and its ICT industry in (a) improving the innovation capabilities and international competitiveness of the ICT industry, (b) accelerating the economic transformation, and (c) promoting green growth. Therefore, China must formulate systematic green ICT policies at the national level. However, because green ICT is such a new topic, it is difficult to establish best practices for a country to follow safely. Even leading countries have not worked on

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