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Building Policies for a Better World

Executive Summaries

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ACEEE
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The China Sustainable Energy Program
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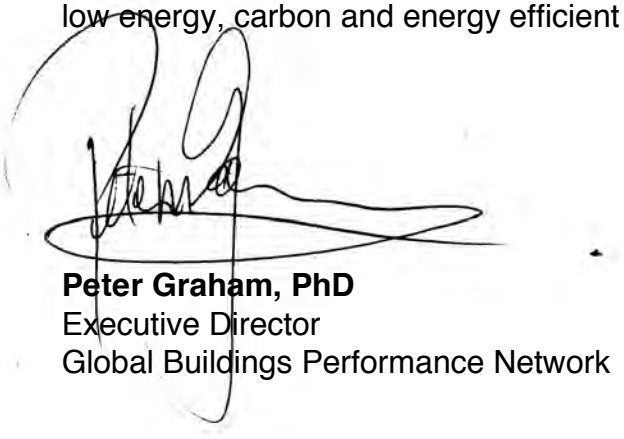
FOREWORD

It is well known that the scale of building development in China is unprecedented. It is also evident that the expansion of the built environment coupled with the impact of energy consumed by China's buildings will have a significant influence on global greenhouse gas emissions. Much of the information available in English about the Chinese building sector elaborates on these well-known themes. However, there are less well-documented insights about the efforts made by China in addressing the challenge of building energy-efficiently on a massive scale. As this report shows, there is much the global community can learn from Chinese best practices.

The rationale for this report was to address the current lack of data on Chinese building energy performance and the effectiveness of building energy policies that is produced and available widely in English. This lack of Chinese data is undermining global attempts to determine the GHG abatement potential of the building sector. The situation also hinders Chinese experts from participating and influencing the discourse on achieving the global abatement potential of the building sector.

Supported by China Sustainable Energy Program (CSEP), a number of key publications have been produced in Chinese, which quantitatively and qualitatively describe the energy performance of buildings in China, present analysis of the effectiveness of building energy codes and complimentary policies, and describe best practices. These publications therefore contain key data and insight that is in demand internationally and can contribute to filling an important knowledge gap.

This study has drawn on these Chinese publications and in consultation with the authors of the status of building energy performance, GHG abatement potential, policy scope and effectiveness, and exemplary policies and buildings that are considered best practice in China. In so doing this work contributes to facilitating one of the shared missions of GBPN and CSEP's Buildings Program - the international exchange of knowledge and expertise on best-practice policies for low energy, carbon and energy efficient buildings in China.



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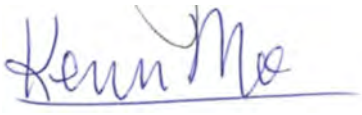

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PREFACE

China has been actively promoting building energy efficiency since the early 1980s, with an increasing concern for sustainable development, national energy security and a growing interest in pursuing a low-carbon economy. Over the course of nearly thirty-years of effort, China has made impressive progress developing and deploying an array of policies, regulations and projects related to building energy efficiency.

In order to help international building energy efficiency experts and energy policy researchers obtain a comprehensive and an objective understanding of China's building energy efficiency policies, Global Building Performance Network (GBPN, http://www.globalbuildings.org/) provided financial support for the development of this report and organized the peer review of the English version. The China Sustainable Energy Program (CSEP, http://www.efchina.org/CSEPCN/FHome.do) provided non-financial support for the development of this report, such as recommending a list of reading materials, introducing relevant building energy efficiency experts in China.

The structure of this report came about as the product of discussions between invited Chinese building energy efficiency experts and the project team. The content of this report comprises key aspects of a series of Chinese government policies and directives related to building energy efficiency, and also incorporates and analyzes the findings of a number of recent Chinese publications (e.g., *Report on Building Energy Efficiency Development in China (2010)* by the Center of Science and Technology of Construction at the Ministry of Housing and Urban-Rural Development (or cited as CSTC (2011) in this report); *Research Report on Annual Development of Building Energy Efficiency in China* by the Building Energy Efficiency Research Center at Tsinghua University (or cited as BEERC (2011) in this report)). Additional information was obtained and summarized from relevant Chinese web pages and through discussions with various Chinese building energy efficiency experts.

The report was first written in Chinese, and was then subjected to two rounds of peer review kindly provided by the invited Chinese building energy efficiency experts. It was then translated into English. Following input from international building energy efficiency experts, the English version was revised; this input is also reflected in the updated Chinese version. The authors of the report are Shui Bin (Chapters 1, 3, 4, 7 and 8) and Li Jun (Chapters 2, 5 and 6, Section 4.1.2, Appendixes A and B). As the report was prepared with some haste and is limited in length, some deficiencies may be present; therefore the authors would be grateful for any feedback readers should wish to provide.

Authors, June 25, 2012

ACKNOWLEDGEMENTS

This report was initially conceived by Peter Graham, Executive Director of Global Building Performance Network (GBPN), and Kevin Mo, building program manager of China Sustainable Energy Program (CSEP).

Both believed that a comprehensive and objective understanding of China's building energy efficiency policies and related activities by international practitioners will serve as a critical step in the pursuance of joint efforts between China and other countries to promote building energy efficiency at national and global levels. Peter and Kevin defined the research scope and established the project team. Kevin narrowed a list of must-read publications for the project team's reference, while also generously providing his time for the guidance of the project team's work.

The very existence of this report can be attributed to the strong support of both Peter and Kevin, as well as ongoing support from GBPN and CSEP.

Two Chinese reports helped us greatly in the preparation of this report: *Report on Building Energy Efficiency Development in China 2010* by the Center of Science and Technology of Construction at the Ministry of Housing and Urban-Rural Development (or cited as CSTC (2011) in this report), and *Research Report on Annual Development of Building Energy Efficiency in China* by the Building Energy Efficiency Research Center at Tsinghua University (or cited as BEERC (2011) in this report).

The report benefited from the valuable input of a group of invited Chinese building energy experts. They are Junqiang Liang and Xiaoling Zhang from the Center of Science and Technology of Construction at the Ministry of Housing and Urban-Rural Development, Siwei Lang and Bo Song from the China Academy of Building Research, Xiu Yang and Da Yan from Tsinghua University, Xing Su from Shanghai Tongji University, and Jianguo Zhang from the Energy Research Institute of the National Development and Reform Commission.

GBPN not only provided financial support for the development of the report, but also organized a list of renowned international building energy efficiency experts to review the reports: Jens Laustsen at GBPN, Joe Huang at Whitebox Technologies, Adam Hinge at Sustainable Energy Partnerships and Anke S. Meyer (senior consultant to the World Bank and ClimateWorks Foundation). We would like to express our sincere appreciation to them for their valuable input: their insightful comments significantly improved the quality of the report.

Last but not least, we would like to thank the teams at GBPN, CSEP, and at the American Council for an Energy-Efficient Economy (ACEEE) for their support

during the development of the report. They are Claire Brule and Alex Wang at GBPN, Kevin Mo at CSEP, and Steve Nadel, Jennifer Amann, Glee Murry and Patrick Kirk at ACEEE.

EXECUTIVE SUMMARY

The construction industry has been a significant mainstay in China's rapid economic development for a number of years, accounting for some 6.6% of gross domestic product in 2009. In recent years China has been adding about 1.7 billion square meters of new floor space on an annual basis (including both urban and rural areas). In 2010, the total area of existing buildings in China was approximately 48.6 billion square meters.

How to improve the building energy efficiency of the soaring number of new buildings and accelerate the retrofit of the huge stock of existing building are two daunting challenges currently facing China.

The report begins with an introduction (Chapter 1) of key concepts and an overview of the administrative structures that play a role in China's building energy use, along with a brief history of building energy efficiency policies in China (Section 1.3). The body of the report is structured as a review of five aspects of China's building energy efficiency: building energy performance (Chapter 2), building energy efficiency policies for new buildings (Chapter 3), building energy efficiency policies for existing buildings (Chapter 4), application of renewable energy to buildings (Chapter 5) and rural building energy use (Chapter 6). The report also provides an assessment of the future prospects and directions for building energy efficiency policy development in China (Chapter 7).

Evolution of Building Energy Efficiency Policies in China

China has pursued the development of its building energy efficiency policies since the early 1980s; this period can be broken down into four development phases (Section 1.3):

- Research preparation (early 1980s to 1986). China began to study building energy use in residential and public[1] buildings, and conducted research on such issues as building energy efficiency technologies and building energy codes.
- Pilot projects (1987-1993). China commenced implementation of demonstration projects at a small scale, examining the implications of these pilots and adapting suitable methodologies for the drafting of policies, regulations and technical standards, with an aim to scaling up and a broader promotion of selected policies.

[1] The definition of public buildings is similar to what is typically referred to as *commercial buildings* in many other countries.

- System formation (1994-2005). China began to put in place the regulatory, administrative, and technological support systems to promote building energy efficiency. During this period China issued building energy codes covering both residential and public buildings for application in each of the climate zones.
- System improvement and policy implementation (2006 to the present). In recent years China has focused on the improvement of the existing regulatory, administrative and technical support systems, promoting the enforcement of building energy codes, residential retrofit, green buildings, and the application of renewable energy in building energy efficiency.

Building Energy Performance in China

Buildings account for nearly one fifth of China's total primary energy consumption and carbon emissions. In 2008, the primary energy consumption of buildings in China was nearly 380 million tons of oil equivalent (excluding biomass energy), or a 1.5 fold increase relative to 1996(Section 2.2).

Energy intensity in buildings differs significantly across different climate zones, which is mainly a consequence of the long winter heating period in the northern regions. In recent years, residential heating energy use has been steadily increasing in the Hot Summer Cold Winter (HSCW) zone, while cooling energy use has skyrocketed in both the HSCW zone and the Hot Summer Warm Winter (HSWW) zone (Section 2.2).

Energy intensity in buildings also differs significantly by building type. For example, electricity intensity in large public buildings (>20,000 square meters) is often 2-3 times higher than that in smaller public buildings (Section 2.4).
Carbon emissions associated with building energy use reached 1,260 million tons in 2008. Both Chinese and foreign experts estimate that there exists huge potential for curtailing the increase in energy demand and greenhouse gas (GHG) emissions reduction by improving energy efficiency in China's building sector (Section 2.5).

Building Energy Efficiency Policies for New Buildings

In addition to the massive level of construction that has taken place over the past decade, it is estimated that China will add a further 10 to 15 billion square meters of residential buildings in urban areas, with an additional 10 billion square meters of public buildings to be built between 2010 and 2020. With this scale of development in mind, the Chinese government has been actively engaged in the formulation and deployment of a series of policy instruments to improve building energy efficiency for new buildings (Section 3.1).

Building Energy Codes.

China has established a relatively comprehensive system of building energy codes for new buildings. This system includes design standards and acceptance codes covering residential buildings in the three major climate zones and public buildings throughout China, along with the main construction processes, which include design, construction, and acceptance. Most noteworthy, the Acceptance Codes makes compliance with building energy efficiency requirements mandatory for the final acceptance of a construction project (Section 3.2.1).

Inspection and supervision are critical components in the enforcement of building energy codes. China's current system of inspection and supervision benefits from strong regulatory support, employment of third parties, and is reinforced by an annual national governmental inspection (Section 3.2.2). According to national inspection data, the compliance rate with building energy codes has improved significantly in the past five years (Section 3.2.4).

Building Energy Efficiency Labelling and Evaluation.

China began to establish its system of building energy efficiency labeling and evaluation in 2006 (Section 3.3.2). There are two types of building energy efficiency labels in place: a building energy efficiency label that relies on theoretical values of building energy efficiency evaluated during the acceptance stage, and a building energy efficiency label that relies on actual values of building energy efficiency evaluated during normal operation (Section 3.3.3).

Since 2009, the Ministry of Housing and Urban-Rural Development (MOHURD) has promoted building energy efficiency labeling in newly built government office buildings and large-sized public buildings through pilot projects in selected provinces and cities. As of 2010, forty-five building projects had been approved and granted star ratings (Section 3.3.4).

Green Buildings.

The year 2004 represented a turning point in the development of green building in China. Within only six years China has managed to develop its technical and management system for green building (Section 3.4.2).
Green building labeling falls under two categories: green building design evaluation labeling and green building evaluation labeling. The two are focused on the design and operation stages, respectively (Section 3.4.3).
From the debut of green building evaluation and labeling in China in 2008 to the end of 2011, a total of 271 buildings were awarded with green building evaluation labels (Section 3.4.4).

Building Energy Efficiency Policies for Existing Buildings

By the end of 2010, the total area of existing buildings in China equaled 48.6 billion square meters, 38.7% of which was located in urban areas. Since the 1990s, the Chinese government has launched a series of policies and provided various types of financial support to promote heat reform and retrofit in existing buildings (Section 4.1.1).

Heat Reform.

Heat reform is an important part of China's drive to improve building energy efficiency. The aim of heat reform in China is to reduce the amount of energy wasted by end users through the reform of the heating pricing system and by establishing market mechanisms and to stimulate heat suppliers' efforts to improve the energy efficiency of their heat supply networks.
By the end of 2010, eighty cities at prefectural level and above in northern heating areas had established consumption-based pricing and billing systems, representing a total of 317 million square meters of building space (Section 4.1.2).

Residential Buildings.

The building energy use of China's northern heating regions accounts for more than 40% of the country's total urban building energy consumption. Most of the residents in the old buildings in this region are low and middle income families living in cities. The residential retrofit in northern heating regions has not only played a very important role in enhancing building energy efficiency, but has also been a significant means by which to improve the quality of housing conditions for urban populations of low and middle income living in this part of the country (Section 4.2.1).

From 2006 to 2010, China completed residential retrofit of 182 million square meters in northern China, while in 2010 alone a floor area of 86 million square meters was retrofitted (Section 4.2.2).

Public Buildings.

The Chinese government has selected government office buildings, large-scale public buildings, and college and university buildings as the targets of its public building energy efficiency improvement initiatives (Section 4.3.1).

By the end of 2010, a wide range of the policies and projects had been implemented relating to government office buildings and large-scale public buildings, including energy consumption data collection (33,000 building units), energy audits (4,850 building units), and public disclosure of energy consumption information (6,000 building units). In the same year, 72 universities carried out energy-saving pilot projects (Section 4.3.2).

Financial Support.

One significant challenge to retrofit is financing. In order to address this issue, the Chinese government has been helping to establish multi-source financing mechanisms for residential retrofit projects in the northern heating regions (Section 4.1.1), and for improving building energy efficiency in government office buildings and large-scale public buildings (Section 4.3.1).

Application of Renewable Energy in Buildings.

China has huge potential for the application of renewable energy resources in buildings. During the 11th Five-Year Period (FYP), the Chinese government introduced a series of incentives and supporting policies to promote renewable energy. MOHURD and the Ministry of Finance issued fiscal policies to promote renewable energy's application in the building sector through pilot projects in designated cities, thereby achieving significant progress.

At present, many provinces and cities have issued local policy regulations for the purpose of promoting renewable energy in buildings. Such policy regulations mainly focus on the promotion and application of renewable energy technologies including photovoltaic power generation, building integrated photovoltaic, solar water heating, and geothermal heat pumps, among others. At the same time, local Departments of Finance have also issued financial support plans and relevant policies. Several local authorities have begun to implement policies making the use of renewable energy in buildings mandatory, while a number of new policies are expected to be implemented during the 12th FYP. However, so far the scope of application of renewable energy in buildings has been quite limited with fairly slow progress due to inadequate financial support.

Rural Building Energy Consumption.

At present total building floor space in China's rural areas is close to 24 billion square meters, accounting for approximately 60% of China's total building area. As there is a huge difference in the economic conditions and standard of living between rural and urban residents, commercial energy consumption and energy intensity in rural buildings have historically been far lower than those in urban areas.

So far, buildings in rural areas in China are built by farmers themselves and are thus exempt from the monitoring and regulatory systems of the central and local governments, while no design standards for energy efficiency of rural buildings have been issued by the relevant government institutions, and building energy performance in rural areas is generally poor (Section 6.1).

An increasing number of rural households have begun to use commercially available fossil fuels while the proportion of biomass in total rural energy use continues to decline. Moreover, the inefficient use of biomass also wastes large amounts of energy and generates significant environmental pollution.

Improvement in building energy performance and promotion of high efficiency household durables via the "household appliances going to countryside" policy campaign constitute two effective ways of reducing building energy use while improving the living environments of households in rural areas across China (Section 6.2).

Assessment and Future Prospects

Making Great Strides.

China has achieved significant progress in improving building energy efficiency over the last two decades, much of which can be attributed to carefully planned development strategies, and strong and consistent support from the central government.

For example, The Chinese government has applied the following general strategy to the promotion of building energy efficiency across the country: (1) prioritization of tasks in a clear-cut manner, (2) beginning first with the more straightforward undertakings before tackling more complex tasks, (3) commencing initiatives from single "points" and expanding to wider "areas." These sound development strategies have helped China to better utilize limited government resources (such as financial and regulatory support), and effectively promote building energy efficiency policies and projects at both national and regional levels (Section 7.1).

Outstanding Challenges.

Chinese officials and building energy experts are clearly aware of the outstanding challenges still to be tackled, including (1) rising building energy consumption, (2) the need for an institutionalized process for the updating of building energy codes, (3) difficulties securing financing for retrofit projects, (4) slow progress in heat reform, (5) scarcity of technologies and management needed for promoting the application of renewable energy in building energy efficiency, (6) inadequate capacity building of relevant stakeholders in building energy efficiency, and (7) the enormous task of promoting building energy efficiency in rural areas (Section 7.2).

The Next Steps.

By 2015, China aims to complete the residential retrofit of another 400 million square meters in the northern heating regions, and will continue to promote heat reform in this region. In addition, government targets call for the complete residential retrofit of 50 million square meters in the HSCW, the thermal retrofit of 60 million square meters of public buildings and the development of 2,000 building energy-efficiency pilot projects to be implemented by public organizations.

What Conclusions Can Be Drawn From This Report?

While it is clear that building energy efficiency policies in China have been developed within the country's unique political, economic and cultural context, and

are therefore not necessarily applicable to other nations, it is nonetheless equally evident that the success of energy efficiency policies in China is critical not only to the energy security and sustainable development of China itself, but indeed of the entire world.

There can be no doubt that the acquisition of a solid understanding of China's building energy efficiency policies and related activities by international practitioners would be conducive to increased exchange of ideas and experiences between China and other countries, thereby directly contributing to the promotion of building energy efficiency in China and elsewhere around the globe.

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About GBPN The Global Buildings Performance Network (GBPN) is a globally organised and regionally focused network whose mission is to advance best practice policies that can significantly reduce energy consumption and associated CO_2 emissions from buildings.