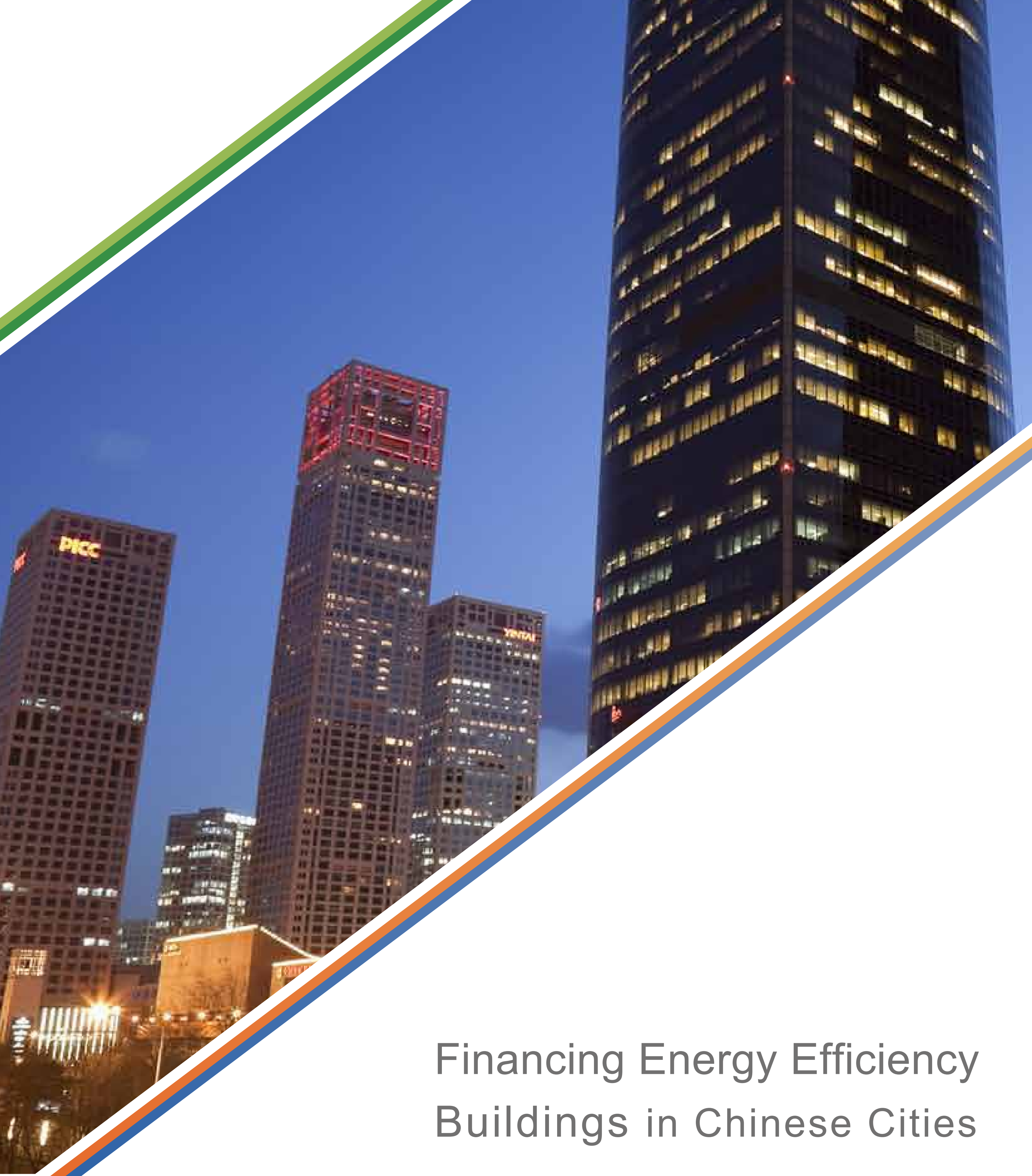

Financing Energy Efficiency Buildings in Chinese Cities

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Author:

Kevin Mo, Ph.D., Paulson Institute

Partners:

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Executive Summary

In March 2016, the National People's Congress (NPC) and the Chinese People's Political Consultative Conference (CPPCC) approved the Outline of the 13th Five-Year Plan for the National Economic and Social Development (2016-2020). One goal stood out among many others – a cap on national total energy consumption by five billion tonnes of coal equivalent (tce). This is yet another national directive of China designed to combat global warming and reach its peak carbon emission level by 2030 or earlier. Indeed, the coming five years will be a critical period for China to transition towards a green and low-carbon economy.

The real challenge is how to translate these critical high-level commitments into actions on the ground, especially in China's fast-growing cities. As cities close or relocate their high energy-consuming and high-emission heavy industries, service-driven tertiary industry is poised to become the mainstay of the urban economy, which means the building sector will account for a growing share of the carbon emissions of cities. In Beijing, for instance, heavy industries represented by Shougang Group have all relocated out of the city as part of a campaign on conserving energy, reducing carbon emissions and tackling air pollution. Today, Beijing ranks first among Chinese cities in terms of tertiary industry's share of city GDP, and its building sector takes a much larger share of the city's total energy use than any other Chinese cities. With continued urbanization, China will see as many as 100 million people migrating to cities from rural areas and becoming official urban dwellers in the next five years, further raising the energy consumption by urban buildings. Therefore, **under the combined impact of the green transition and urbanization, Chinese cities will have to tackle the challenges of increasing carbon emissions from the building sector.**

Chinese cities' efforts can be broadly categorized into two approaches, both of which are heavily reliant on government subsidies through non-market-based financing mechanisms. The first one pertains to development of new city zones. Massive districts of high-star green buildings[1] are usually planned, but many will never leave the blueprint stage. The incremental costs for constructing a district of high-star green buildings are prohibitively high without injection of private capital. Greening of existing buildings presents its own set of financing challenges. During the 12th Five-Year Plan period (2011-2015), although over 700 million square meters of existing residential buildings in northern China were retrofitted to improve their energy performance, over 80 percent of the costs were subsidized by central and local governments. Private capital rarely contributed due to the following barriers:

1. Lack of mid- and long-term planning on building energy efficiency
2. Slow update of building energy standards and inadequate investment in related fundamental research

1. China's green building evaluation system ranges from 1- to 3-star, with 3 being the greenest and 1 reaching the minimum requirements for a green building. Buildings classified as 2- or 3-star are considered "high-star".

3. Overreliance on fiscal subsidies and absence of market-based mechanisms

4. Disconnection of the two green building labels

5. Slow progress in public disclosure of building energy data

This report shows that, during the **13th Five-Year Plan period, Chinese cities will need to invest RMB 1.65 trillion in building energy efficiency (USD 250 billion)**, to support the construction of greener buildings as well as the retrofitting of massive older houses and commercial buildings. Given the size of the required investment, it is evident that government funds alone will not be sufficient to help Chinese cities make the green transition. **Green financing models will be needed to play a pivotal role in attracting private investment to fill in the huge financial gap**.

Private capital has already shown a mounting interest in green finance, with some investors and companies experimenting with investing in green buildings as a way to mitigate potential carbon risks in the long term. How to efficiently leverage the fiscal budget and develop market-based financing tools, so as to attract private capital to fund green city development as well as retroftting existing city districts, will be the key for Chinese cities to transition to a low-carbon economy.

Financing and energy policy must go hand in hand for scaling building energy efficiency. This report proposes the following recommendations to spur market-based financing mechanisms in Chinese cities:

- Green Building legislation
- Adopt a long-term national plan on building energy efficiency
- Mandate public disclosure of building energy data
- Establish third-party evaluation mechanisms for green buildings
- Encourage concessional loans to high-star green buildings
- Establish insurance guarantee standard for green buildings
- Mandate insurance policy for building retrofits
- Establish green building development funds
- Issue municipal bonds for urban-scale building retrofits
- Encourage international cooperation and international green loans and funds

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Foreword

China's sustained and rapid economic growth in the past three decades has made it the second largest economy in the world, but also the largest carbon emitter. This year marks the beginning of the 13th Five-Year Plan (FYP) period (2016-2020) and a "new normal" for the country's economic development: China has lowered its forecast on GDP growth rate and is under pressure of further economic decline. The development course that China takes during the next five years might very well determine whether it can avoid falling into the middle income trap[2].

The good news is that the central government, with its firm commitment to reducing energy consumption and carbon emissions, is prepared to fully leverage the opportunities created by the economic slowdown to transform the country's industrial structure and energy mix, remove over-capacity of energy-intensive and high-emission industries such as steel and coal, and pave the way for China's transition to a low-carbon economy. At the annual meetings of the National People's Congress (NPC) and the Chinese People's Political Consultative Conference (CPPCC) in March this year, the government proposed the goal of capping total energy consumption at five billion tonnes of coal equivalent (tce). On April 22, Zhang Gaoli, the Vice Premier of the State Council, signed the Paris Agreement on climate change at the United Nations headquarters in New York, formalizing China's commitment to peaking its carbon dioxide emissions by 2030 or earlier.

There is neither any doubt about the central government's determination to tackle climate change nor any ambiguity about its long-term goals. The attainment of these goals, however, hinges on the capacity of local governments at all levels to implement and enforce them. The provincial and municipal governments will be the vanguard in energy conservation and emission reduction efforts, because, as a result of rapid urbanization, cities are China's prime carbon emitters. The pressure to reduce energy consumption and air pollution has prompted mid-to-large cities, most of which are concentrated in China's economically developed coastal regions, to begin closing down or relocating high energy-consuming industries starting from the 11th FYP period (2006-2010). Meanwhile, the shift towards a services-driven economy is taking shape as the share of urban GDP contributed by service industries has been steadily growing. These economic shifts, combined with the continuing resettlement of rural populations to urban areas and the rising income of urban residents, mean that buildings will account for a growing percentage of cities' energy consumption going forward.

China already has mandatory building codes pushing for energy efficiency in new construction, focusing primarily on urban residential and public buildings[3]. This year marks the 30th anniversary of the country's first building efficiency codes, and yet large-scale efficiency initiatives only started in the middle of the 11th FYP period (around 2008), in the form of retrofitting residential buildings in

2. The middle income trap is a theorized economic development situation, where a country which attains a certain income will get stuck at that level.

3. In the Chinese classification of building types, "public buildings" usually refer to non-industrial and non-residential buildings, which include commercial buildings, administrative offices of government agencies, schools, hospitals, and sports centers, etc.

northern China, where district heating systems dominate. During the 12th FYP period (2011-2015), the central government started retrofitting residential buildings in hot-summer and cold-winter regions and public buildings across the country. Both the financial resources that Chinese government has poured into retrofitting existing buildings and the resulting achievements are unprecedented in the world. But because a market-based mechanism has yet to be established, the central and local governments have to invest tens of billions of yuan in energy retrofits of buildings, with private capital contributing very little. Therefore, urban building retrofits have relied almost exclusively on government subsidies and will slide into stagnation when the government financial support is cut off.

Since the creation of a voluntary rating system for green buildings in 2008, over 500 million square meters of buildings had been certified with the green building label as of the end of 2015, falling short of the goal of one billion square meters set by the central government. This is partly due to the fact that the green building subsidy program announced by the Ministry of Finance in 2012 was never implemented--underscoring how heavily the promotion of green buildings relies on fiscal subsidies under the current financial system.

Given the enormous investment required to support the construction of high-star green buildings, as well as the large-scale greening and energy retrofits of older houses and commercial buildings, it is evident that government subsidies alone will not be able to help Chinese cities make the green transition. Market-based green financing models will play a pivotal role in filling the huge financial gap.

This report estimates the financial gap for Chinese cities to scale energy efficiency buildings during the 13th FYP period, and explores how to use market-based financing instruments to attract private capital, particularly in relation to the construction of high-star green buildings and energy retrofits of existing residential and public buildings. Passive buildings and zero-energy buildings are still at the pilot stage, and should be supported by government subsidies. But they are not ready for large-scale implementation during the 13th FYP period, and therefore excluded from this study.

Chapter 1 describes how China's urbanization process and green transition have caused the building sector's carbon emissions to continue to rise. Chapter 2 provides an estimate of the financing needs and financing gap for scaling energy-efficient building in cities during the 13th FYP. Chapter 3 reviews the existing investment and financing models, and Chapter 4 proposes several green financing schemes for attracting private investment.

Kevin Mo, Ph.D.

Managing Director, Paulson Institute (US) Beijing Representative Office

April 2016

Chapter 1: Building Energy Efficiency in Chinese Cities

This chapter will describe how China's urbanization process and green transition have caused the building sector's carbon emissions to continue to rise, and recap the policies and actions Chinese cities have taken with regard to low-carbon transition.

1. Urbanization Drives Up the Number and Scale of Chinese Cities

4. Building Energy Conservation Research Center, Tsinghua University. "2016 Annual Report on the Development of Energy Efficiency Buildings in China." China Construction Industry Press, 2016, Page 2.

Urbanization has been the engine powering China's economic surge. As rural populations migrate to cities, both the size and number of cities have increased significantly. Starting from a mere 37.7 percent in 2001, China's urbanization rate has been gaining an average of more than one percentage point per year (Figure 1). More than 500 million people have migrated from the countryside to cities during the 35-year span from 1980 to 2015, and an additional 100 million are expected to move to cities in the next five years based on the 13th Five Year Plan (2016-2020) that has set the national goal for the urbanization rate at 60 percent.

The fast-growing number and scale of Chinese cities has prompted the central government to revise how cities are classified by size. On November 20, 2014, the revised standard of city categorization issued by the State Council clearly demonstrates the continuing growth of Chinese cities (Table 1). In addition to raising both the upper and lower thresholds for each category, the new classification has also increased the number of city types from four to five by adding a fifth category: megacity with over 10 million residents. By the previous standard, any city with a population close to one million would be a large city; under the new standard, such a size would only qualify a city as a medium-sized city.

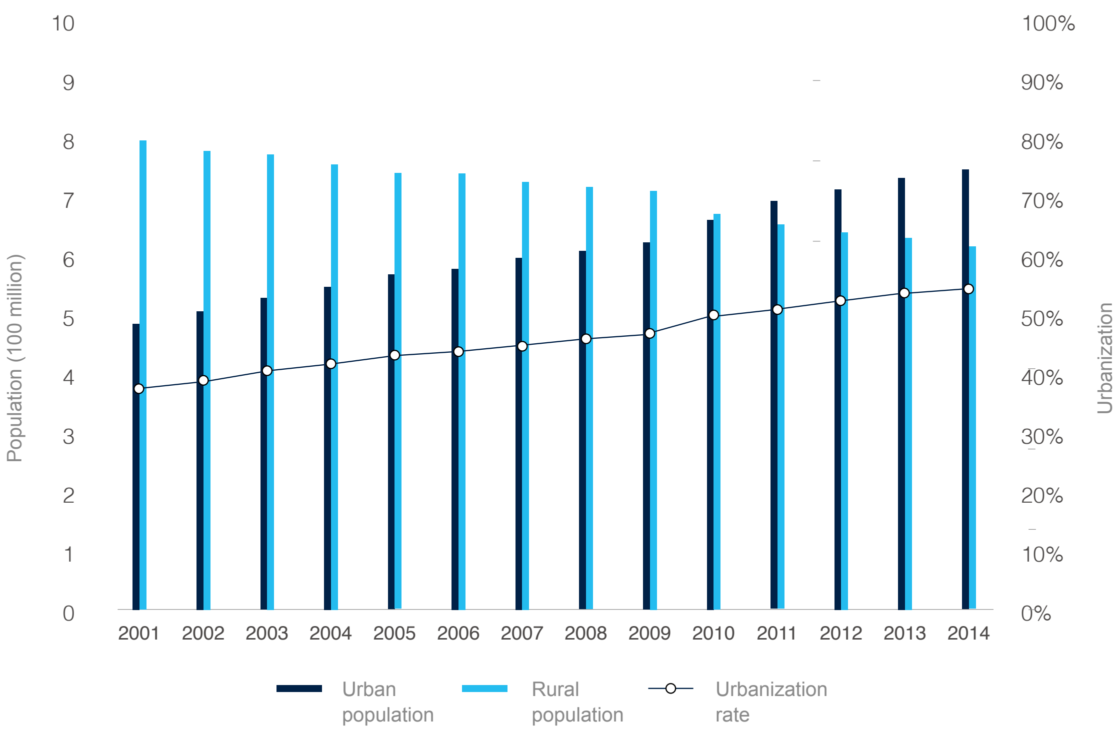


Fig. 1: Change in China's Urban and Rural Populations and Urbanization Rate (2001-2014) [4]

	New Standard			Old Standard
Small cities	< 500,000	Type I	200,000–500,000	< 200,000
		Type II	< 200,000	
Medium-sized cities	500,000–1 million			200,000–500,000
Large cities	1–5 million	Type I	3–5 million	500,000–1 million
		Type II	1–3 million	
Super-large cities	5–10 million			> 1 million
Megacities	> 10 million			N/A

Table 1: Comparison of the Old and New Standards for the Classification of Chinese Cities[5]

In 2013, China had 11 super-large cities, with seven of these boasting a population of over 10 million (megacities). By 2015, according to an OECD report, the number of megacities in China had increased to 15 (Figure 2). Data also show that the size of a city is positively correlated to its per capita GDP (Figure 3). Specifically, the per capita GDP in super-large cities is almost 67 percent higher than that of Type I small cities, which underlines the importance of urbanization to maintaining China's economic growth.

5. "Circular of the State Council on Adjusting the Criteria for Classification of the Scale of Cities," Xinhua, November 20, 2014, accessed at http://www.gov.cn/xinwen/2014-11/20/content_2781156.htm

6. International media: China has at least 15 megacities in addition to Beijing, Shanghai, Guangzhou and Shenzhen." Phoenix International, April 21, 2015, accessed at http://finance.ifeng.c1/13651513_0.shtml.

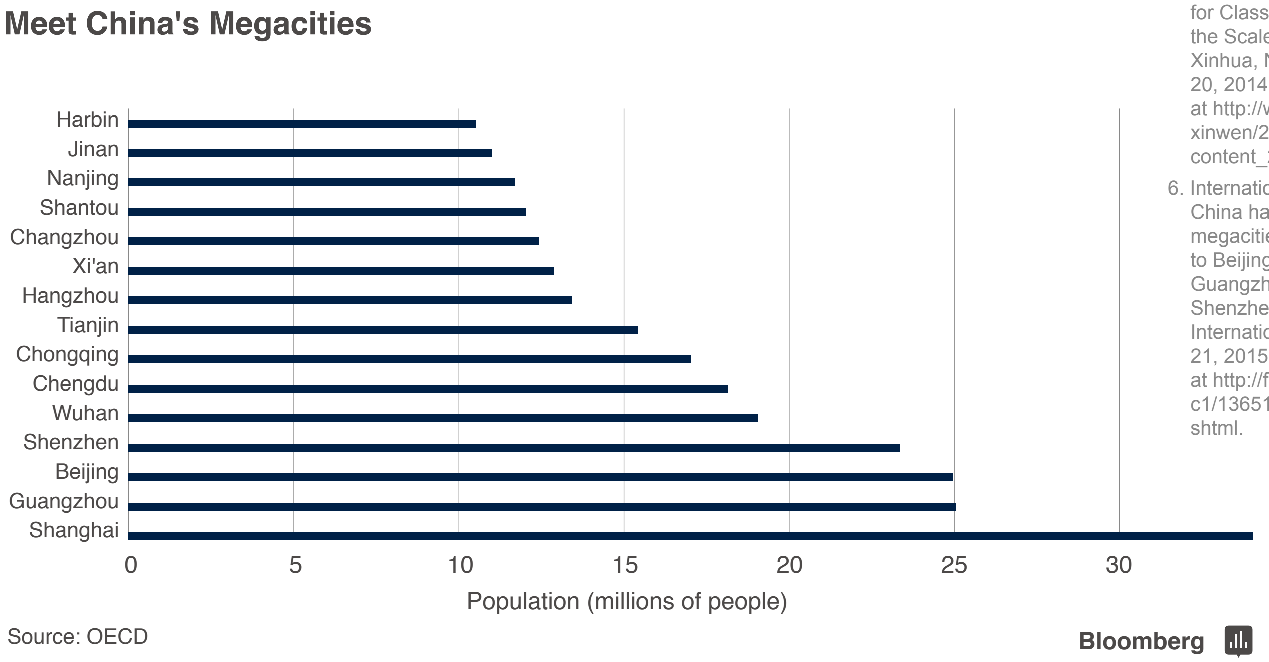
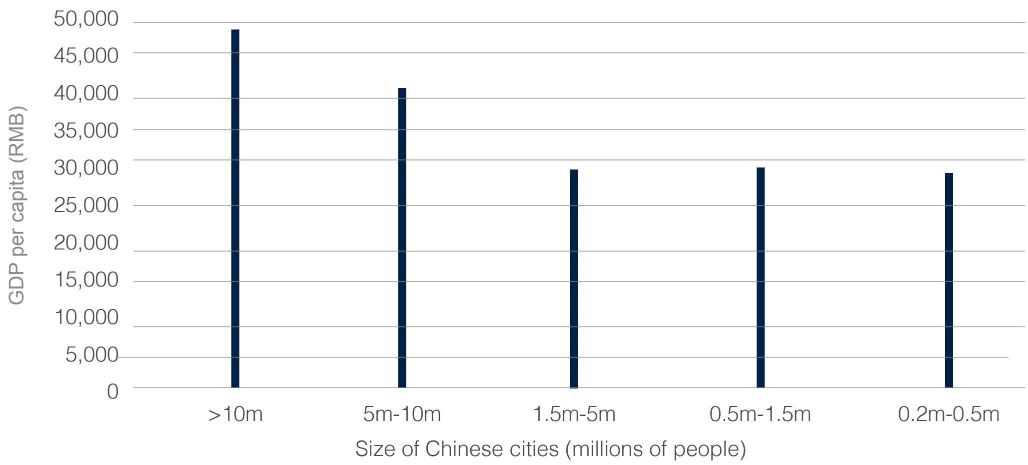


Fig. 2: Number of China's Super-Large Cities and Megacities is Double the UN Estimate[6]

Big Cities Are More Productive

The greater the population, the greater GDP per person



Source: OECD, based on data from National Bureau of Statistics of China
*Growth numbers from 2006-2010

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Fig. 3: Larger Cities Have Higher Per Capita GDP[6]

2. Urbanization Drives Up Total Floor Area and Energy Consumption of Buildings

According to a study by Tsinghua University[4], rapid urbanization has fueled the boom of the construction sector in China. As Figure 4 reveals, between 2001 and 2014, the floor areas of both urban residential and public buildings in Chinese cities grew steadily, while the total floor area of rural residential buildings stayed mostly flat. In 2014, urban residential and public buildings reached 21.3 billion square meters and 10.7 billion square meters, respectively. The urban buildings account for 57 percent of the domestic total gross floor area. The cited study also suggests that China's total building floor area should be kept below 72 billion square meters, in order to curb carbon emissions from the building sector.

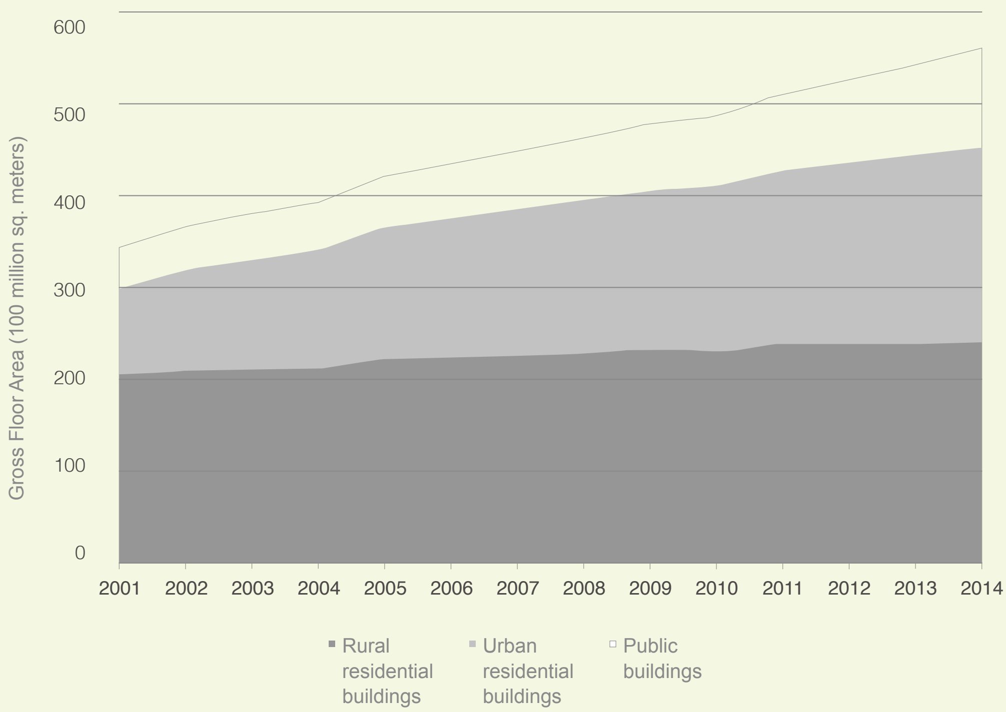


Fig. 4: Building Floor Areas in China (2001-2014) [4]

Higher building stock and enhanced living standards are directly responsible for the increasing energy use of the construction sector, mainly stemming from new construction processes and building operations. The aforementioned study indicates that in 2014, construction activities accounted for about 16 percent of China's total energy consumption while building operations made up another 20 percent, meaning 36 percent of China's total energy consumption was attributed to the building sector. Another study believes that building operations in fact consumed 28 percent of the energy use in China[7], which would make the construction sector account for as much as 44 percent of China's total energy consumption. Figure 5 shows steady increase in both the total energy consumption and electricity consumption by buildings.

7. Center for the Development and Promotion of Science and Technology, Ministry of Housing and Urban-Rural Development. "Report on Building Energy Efficiency in China 2010." China Construction Industry Press, 2010, page 1.

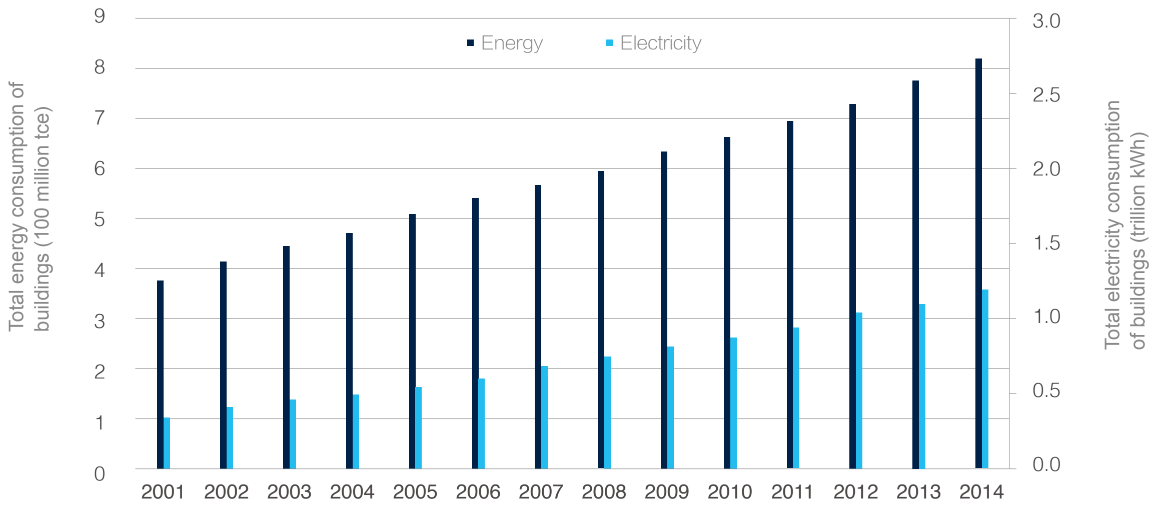


Fig. 5: Total Energy and Electricity Consumption of Buildings (2001-2014)[4]

3. Low-Carbon Transition Pushes Up Relative Carbon Emissions of Urban Buildings

8. Beijing Municipal People's Government. "Outline of the 13th Five-Year Plan of National Economic and Social Development for Beijing Municipality." Website of Beijing Municipal Development and Reform Commission, 2016.
9. "Xicheng District: Half of China's Financial Assets in One City Block." Beijing Daily, June 8, 2012, accessed at http://news.sina.com.cn/c/p/2012-06-08/180724560791.shtml.
10. Li Shixiang. "Speech at the First Beijing Financial Street Forum." Xicheng District, Beijing (official website), November 19, 2012. Accessed at http://www.bjxch.gov.cn/XIChdjl/XICzxft/XICzxftxxq.ycs?GUID=557318.
11. Cai Weiguang. "Study on the Calculation of Energy Consumption in Buildings at the Provincial Level and Forecast of Energy Conservation Potentials." Sponsored by the Energy Foundation, 2013.

Cities are the single largest source of carbon emissions in China. This is because traditionally, Chinese cities are planned and developed around the industrial sector, which is a major carbon emitter accounting for about 65 percent of total carbon emissions. To achieve its goal of peaking carbon emission levels as early as possible, China must shift towards a low-carbon economy by increasing the proportion of service-driven tertiary industry in its cities, such as the financial sector or entertainment industry. Building operations make up the lion's share of the energy consumption of these tertiary industries. Therefore, the move of Chinese cities towards a sustainable economy will directly raise the proportion of carbon emissions from building operations in cities.

Beijing provides a clear example of this economic shift and how it has played out over the past decade. As China's capital, Beijing is one of the leading Chinese cities to move towards a sustainable economy and has also invested the most in low-carbon transition. Located in the Beijing-Tianjin-Hebei region (also known as Jing-Jin-Ji), where air pollution is the most problematic in the country, Beijing has been relocating energy-intensive and polluting industries out of the city since the 10th FYP period (2001-2005). During the 12th FYP period, another 1,300 general manufacturing and polluting companies were either closed or phased out.[8] Today, Beijing has successfully completed its transition from an industrial city symbolized by the Shougang Group, a steel-and-iron manufacturer, to a new-economy city where the service sector, led by Financial Street and the Central Business District (CBD), makes up 80 percent of its GDP. In 2012, the value of financial assets held or managed by entities along Financial Street had already reached RMB 56.4 trillion (USD 8.96 trillion), accounting for half of China's financial assets [9]. Financial Street contributed over one-third of the city's tax revenues, serving as the key engine for Beijing's economy. [10]

This low-carbon transition brought forth by

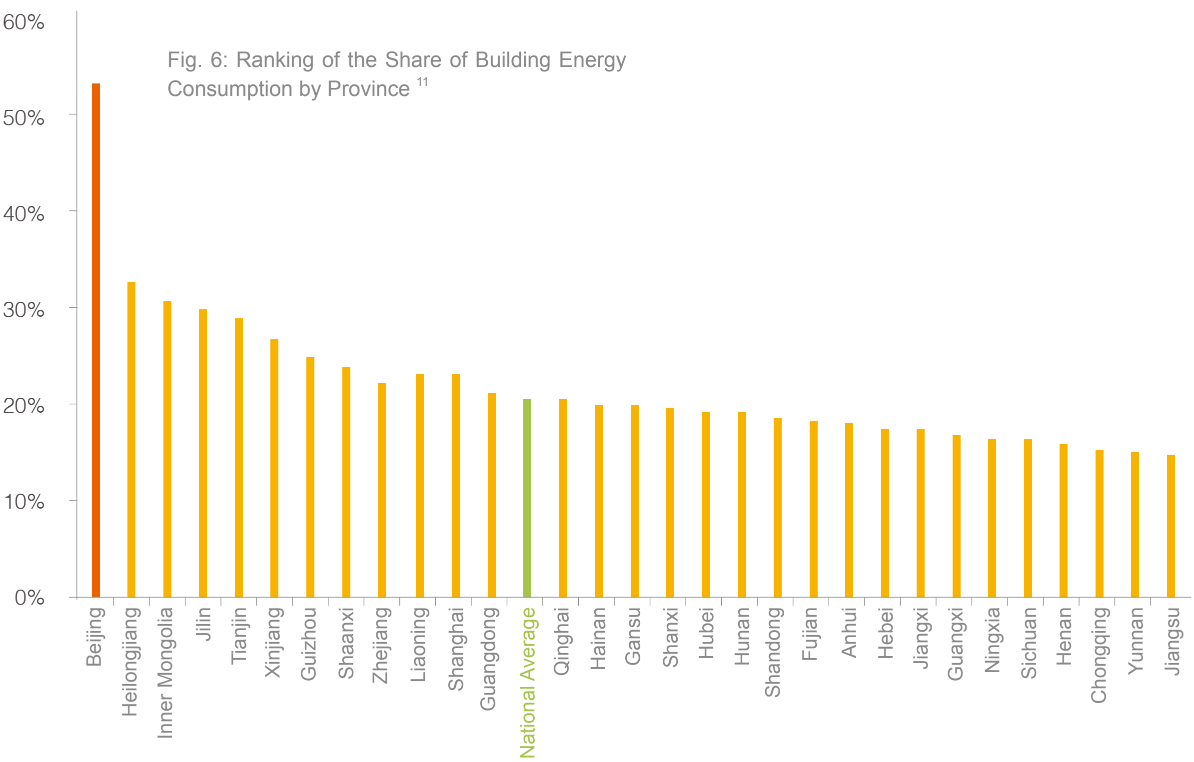
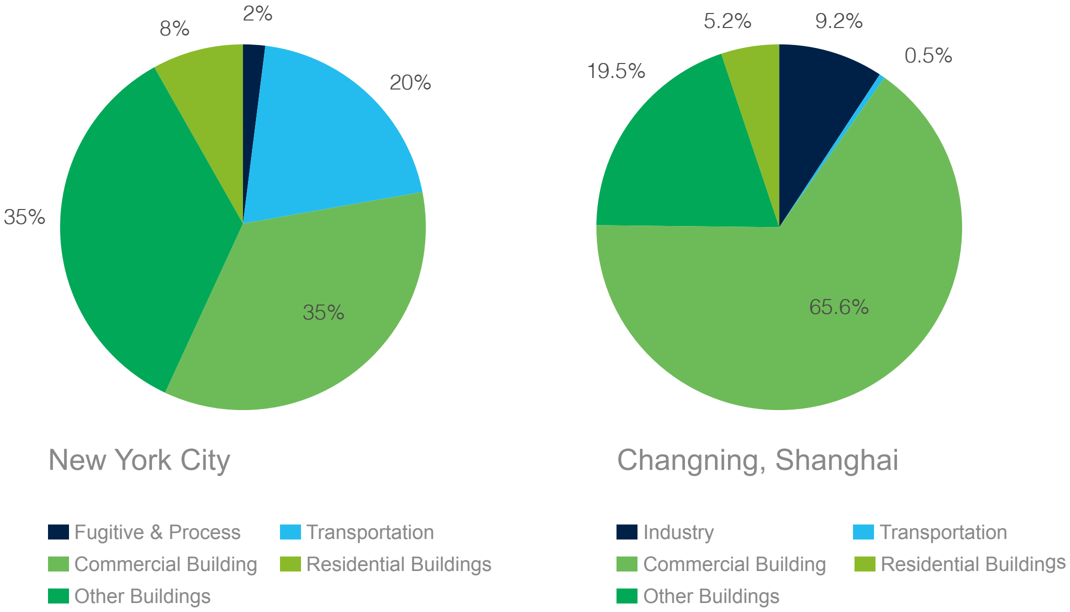


Fig. 6: Ranking of the Share of Building Energy Consumption by Province [11]

burgeoning tertiary industries has elevated the relative energy consumption of buildings in cities. For most cities in China, buildings currently account for 20 to 25 percent of the municipal energy consumption, which suggests that the secondary industry is still a dominant force for most cities. By contrast, Beijing already saw its buildings consuming more than 50 percent of the total energy as early as 2010, allowing it to take the first place among Chinese cities with a comfortable margin (Figure 6)[11]. This present outlier is indicative of the dynamic changes that will be coming to the composition of carbon emissions in Chinese cities in the next two decades. As a comparison, buildings accounted for more than 75 percent of the total carbon emissions of New York City in 2012.[12]

Although for most Chinese cities buildings account for only around 20 percent of their total carbon emissions, the carbon emission profile of their central districts is already approaching that of New York City, where buildings account for more than 75% of carbon emissions. Using Shanghai, the commercial and economic hub of China, as an example: despite the significant share of industrial emissions from large-scale heavy industries such as the Shanghai BaoSteel Group, buildings in the most affluent central districts, including Huangpu and Changning districts, account for about the same percentage of municipal energy as that found in New York City (Figure 7). These districts have to focus on the building sector for cutting carbon emissions in order to accomplish the carbon abatement objectives assigned by the municipal government.

12. J. Dickinson et al. "Inventory of New York City Greenhouse Gas Emissions." Mayor's Office of Long-Term Planning and Sustainability, New York, 2012.



Source: Carbon Emissions Report of New York, 2012 and the Cost Curve Study Report for the Low-Carbon Experiment Area of Changning District, Shanghai Municipality

Fig. 7: Carbon Emission Sources in New York City vs. Changning District, Shanghai

4. Recap on China's Effort in Promoting Building Energy Efficiency

4.1 Laws and Regulations

The year 2008 marked a watershed moment for China in its march towards law-based governance for energy efficiency in buildings. The revised Energy Conservation Law that took effect in April of that year established the work relating to enhancing the energy efficiency of buildings and how such work should be supervised and managed. The Regulations on Energy Conservation in Civil Buildings promulgated in October that year added further details to the legislation and was designed as a more specific guideline for on-the-ground work. These two national legal documents were followed by a string of regional regulations enacted by provincial, municipal, and local governments. In this manner, China has developed a legal system on energy-efficient buildings, with the Energy Conservation Law serving as the upper-level law, the Regulations on Energy Conservation in Civil Buildings supplying practical guidelines, and local regulations providing tailored support at the implementation level, signifying that the energy efficiency of buildings has been moved into a law-based governance system.

4.2 Building Standards and Codes

China adopted three national energy efficiency standards for residential buildings in three different climate zones. The three climate zones are: the cold and severe cold zone in northern China, the hot-summer-and-cold-winter zone along the middle and lower reaches of the Yangtze River, and the hot-summer-and-warm-winter zone in southern China. The national energy efficiency standard for public buildings and the national evaluation standard for green buildings, by contrast, are applicable across the country. Energy efficiency standards are benchmarked by the energy consumption level of buildings in the 1980s, and should be updated every five years, though in practice the updates often fail to meet this timeline.

Major Standards		1986	1995	2001	2003	2005	2006	2010	2012	2015
Design Standard for Energy Efficiency of Residential Buildings	Cold and Sever Cold Zones	Issued (30%)	Revised (50%)					Revised (65%)		
	Hot-Summer-Cold-Winter Zones			Issued (50%)				Revised (65%)		
	Hot-Summer-Warm-Winter Zones				Issued (50%)					
Design Standard for Energy Efficiency of Public Buildings						Issued (50%)				Revised (62%)
Evaluation Standard for Green Buildings							Issued			Revised

Note: percentages in parentheses indicate how much energy is saved versus baseline figure.

Table 2: Revision Timline of National Building Energy Efficiency Standards

4.3 Current Status of Energy Efficiency Buildings in Cities

China's efforts on improving building energy efficiency are concentrated in the following areas: tightening the energy efficiency standards for new buildings, energy retrofits of existing buildings, application of renewable energy in buildings, and development of green buildings and green ecological districts. Among these options, new energy-efficient buildings and building retrofits present the largest potential for carbon emissions reduction.

4.3.1 Improving Energy Efficiency of New Buildings

Imposing energy efficiency standards on new buildings is widely regarded as the most effective policy tool for energy conservation in the building sector, if the standards are compulsory and enforced through adequate local supervision. Additionally, every revision to the standards should be more stringent. Provincial and municipal governments can only set tougher standards than the national ones.

Given that China's urbanization is in full swing, housing is in high demand in many cities. A new house with poor energy performance can be easily sold to uninformed homebuyers, and non-compliant developers can make higher profit by installing less efficient windows or insulation, thereby cutting down costs. The key to promoting energy efficiency for new buildings is local enforcement. Fiscal subsidies should not target new standard compliant construction, as this will diminish the mandatory nature of energy efficiency standards and give developers receiving no subsidies an excuse for non-compliance.

4.3.2 Improving Energy Efficiency of Existing Buildings

During the 11^{th} FYP period (2006-2010), the Ministry of Housing and Urban-Rural Development (MOHURD) planned to retrofit 150 million square meters of inefficient residential buildings in northern China, where district heating dominated. The initiative got off to a rocky start in 2008 but ended up with a total of 182 million square meters of residential buildings being retrofitted by 2010. In the beginning, local governments had a lukewarm response to the Ministry of Finance's subsidies, RMB 55 (USD 7.53) per square meter for severe-cold regions and RMB 45 (USD 6.2) per square meter for cold regions. Less than 40 million square meters of buildings were retrofitted by the end of 2008, falling short of the annual goal of 50 million. Starting in 2009, the Ministry of Finance and MOHURD changed the funding mechanism by setting up a startup fund to jump-start retrofits and allotted the task of retrofitting to 15 provinces in northern China.

During the winter of 2008, retrofitted residential buildings demonstrated considerable energy savings and improved comfort level. Indoor temperature increased by 3 to 5 degrees Celsius across the board; walls were no longer eroded by condensation and mold; noise level dropped; heating-related energy consumption reduced sharply; and the resale value of retrofitted homes went up by RMB 300 to RMB 1,000 (USD 41 - 137) per square meter. These benefits kindled the enthusiasm of local authorities who redoubled their efforts in 2009. By the end of the 11^{th} FYP period, The central government dispensed RMB 9 billion (USD 1.32 billion) in financial incentives, which attracted RMB 45 billion (USD 6.59 billion) of investment in relevant industries and created 300,000 jobs.

During the 12^{th} FYP period, MOHURD proposed an

13. Report on Building Energy Efficiency Improvement in China (2014), Center for the Development and Promotion of Science and Technology, MOHURD, China Construction Industry Press, March 2014. ISBN 978-7-112-16507-0.

14. "Interim Measures for the Management of Energy Retrofitting Subsidies for Existing Buildings in Hot-Summer-Cold-Winter Zone", Cai Jian [2012] No. 148, Ministry of Finance, 2012.

15. "Circular of the Ministry of Finance and MOHURD on Further Advancing the Energy Conservation Project of Public Buildings", Cai Jian [2011] No. 207, Ministry of Finance, 2011.

expanded program to retrofit another 400 million square meters of residential buildings in northern China. Boosted by the experience and success from the 11th FYP period, local governments in northern China actively asked for more assignments from MOHURD rather than waiting passively for their assignment. Three hundred and forty-seven million square meters of residential building underwent retrofits just in 2011 and 2012, bringing the cumulative subsidies paid by the central government to more than RMB 17 billion (USD 2.7 billion).[13] Because the dedicated funds became exhausted much faster than expected, MOHURD had to postpone its retrofitting plan for the next few years; related activities came to a screeching halt as a result. The sharp contrast in how enthusiastically local governments in northern China responded in the 11th FYP period versus the 12th FYP period underscores the pivotal role of fiscal subsidies in building retrofits.

During the 12th FYP period, MOHURD set new goals to expand retrofitting to other areas: 50 million square meters of residential buildings in the hot-summer-and-cold-winter zone and 60 million square meters of public buildings nationwide, backed by another injection of subsidies in collaboration with the Ministry of Finance.[14,15] Specifically, RMB 20 (USD 3) per square meter was provided for accomplishing the new goals. By the end of 2014, RMB 477 million (USD 78.8 million) had been invested by government in retrofitting residential buildings in the hot-summer-and-cold-winter regions and RMB 460 million (USD 70.7 million) in retrofitting public buildings across China.[13]

Currently, retrofitting of existing buildings primarily relies on the fiscal subsidies of central, provincial, and municipal governments. As of the end of 2012, China's building stock reached 50 billion square meters, only 20 percent of which met energy efficiency standards. Indeed, there are more than three billion square meters of residential buildings with poor efficiency in the cold regions in northern China alone. Over the past seven years, China has retrofitted some 700 million square meters of buildings which are bankrolled by an estimated RMB 100 billion (USD 15.9 billion) of public funds, consisting of 40 billion from the central government and the rest from local governments. Even if spending continues at the current magnitude and pace, the goal for an early peak of energy consumption by urban buildings still looks elusive. Therefore, public finance must tap into the potential of the financial market by encouraging participation of private capital.

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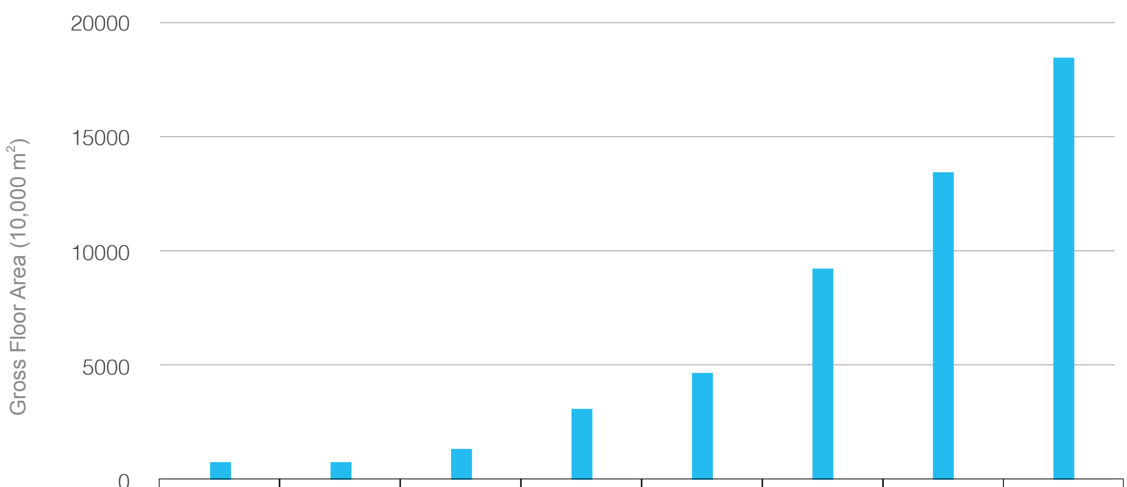
4.3.3 Green Buildings

The voluntary Green Building Evaluation Standard was released in 2006. According to the standard, “green buildings” are buildings that, throughout their entire lifecycle, are able to maximize resource conservation (conservation of energy, land, water, and materials), protect the environment and reduce pollution, provide healthy, habitable, and efficient living space, and promote residents’ harmonious coexistence with nature. Green buildings in China are classified into 1-Star, 2-Star and 3-Star buildings, with 3-Star buildings being the greenest. Related rating labels include one for design and the other for operations. In addition to energy efficiency requirements, green buildings in China must also meet requirements on land, water, and materials savings and on environmental quality, usually incurring incremental “green” costs. As revealed by one cost analysis on green building projects[16], the incremental costs for high-star buildings normally exceed that of lower-star buildings, while the incremental cost is rather limited for 1-Star buildings. Indeed, a 1-Star green building that is carefully designed in the context of its environment almost incurs no additional cost to its developers.

In 2008, MOHURD launched a voluntary evaluation system for green building projects. In 2012, China took one step further by setting the goal of constructing one billion square meters of green buildings by 2015 and creating an incentive plan for green buildings of 2-Star and above[17], in which 2-Star buildings are incentivized at RMB 45 yuan/ m^2 (USD 7.15) and 3-Star buildings at RMB 80/ m^2. (USD 12.71), due to the difficulty of verifying whether buildings with design evaluation labels can still meet the green building requirements for actual operations, this national incentive plan never took off, and the goal of constructing one billion square meters of green buildings by 2015 collapsed as well (Figure 8) with only 472 million square meters completed. To encourage the large-scale development of green buildings, the Ministry of Finance once provided a subsidy of RMB 50 million (USD 8.1 million) to any new green district. A total of RMB 400 million (USD 65.5 million) in subsidies was given to eight green ecological cities in 2013, but the subsidy program was discontinued thereafter.

16. Ye Zuda. Low-Carbon Green Buildings: From Policy to Economic Cost-Benefit Analysis, China Construction Industry Press, January 2013.

17. “Opinions on Accelerating the Development of Green Buildings in China.” Cai Jian [2012] No. 167, Ministry of Finance, 2012.



	2008	2009	2010	2011	2012	2013	2014	2015
GFA	141.22	99.47	723.43	2523.52	4096.67	8707.1	12943.71	17982.2

Fig. 8: Annual Floor Areas of Evaluated Green Buildings (2008-2015)

5. Challenges to Scaling Energy Efficiency Buildings in Chinese cities

Efforts made by the Chinese government to promote energy-efficient buildings and green buildings have not gone unnoticed. According to the survey of the American Council for an Energy-Efficient Economy (ACEEE) on major world economies, which is conducted once every two years, China ranked first for two consecutive times in the area of building energy efficiency (2012[18] , 2014[19]). Nevertheless, the following challenges still exist:

1) Lack of Mid- and Long-Term Planning

At present, China's national energy-efficiency building programs and green building programs are primarily planned and implemented through Five-Year Plans. Yet promoting building energy efficiency often requires medium- and long-term planning beyond five years. A transparent long-term policy should be established to encourage private capital to invest in building energy efficiency related products and technologies. The United States and the European Union have already announced their respective ultimate goals for energy efficiency buildings, which include a timetable and roadmap to achieving zero-energy buildings or near zero-energy buildings. China's official energy efficiency policy has yet to recognize or incorporate near zero-energy building targets. Moreover, updates to Chinese standards on building energy efficiency only take place once every five years and are often out of sync with the Five-Year Plans. Due to timing mismatch, standards are often updated without definitive targets and directions, missing great opportunities to maximize energy savings.

2) Slow Update of Energy Efficiency Standards and Inadequate Fundamental Research

Although it is stipulated that building energy efficiency standards should be updated every five years, this rule is not strictly enforced. For example, the revised national energy efficiency standard for public buildings took effect in 2015, and its previous edition was issued as long as a decade ago. These ten years happen to be the peak time for China's new construction. Not only did the outdated energy efficiency standard fail to meet market demand, but in some instances it even hampered technological progress and innovation. In addition, the national team for revising building energy efficiency standards is only convened on an ad hoc basis and disbanded right after the completion of work. Due to the lack of research on fundamental issues that require continuous studies, the quality of standards has also been compromised.

18. Sara Hayes et al. "International Energy Efficiency Scorecard." ACEEE Report, 2012, accessed at http://www.ssti.us/wp/wp-content/uploads/2012/07/internation-energy-efficiency-scorecard.pdf.

19. Rachel Young et al. "The 2014 International Energy Efficiency Scorecard." ACEEE Report Number E1402, July 2014.

3) Overreliance on Fiscal Subsidies and Absence of Market-based Mechanisms

Of all China's efforts on improving building energy efficiency in cities, the most fruitful project has been the retrofits of residential buildings in northern China, which has also received the most fiscal support. However, when highly relying on fiscal subsidies, market mechanisms and private capital have been virtually ignored. The success has not been built upon a sustainable financing model. Additionally, over-reliance on public funds led to excessive intervention of the government, further deterring private capital from entering the market of building energy efficiency.

4) Disconnection of Two Green Building Labels

There are two evaluation labels for green buildings – one for design and the other for operations – corresponding to the two phases of evaluation. After receiving a green label certification in the design stage, which only requires an assessment of blue-print design, the majority of developers tend not to pursue a green label for operational performance that requires on-site testing after the building is occupied. Developers run the risk of failing the test after the properties have already been sold. Unable to verify the actual "green performance" of certified green buildings makes the Ministry of Finance reluctant to implement the over-due subsidy program for promoting green buildings.

5) Slow Progress in Public Disclosure of Building Energy Data

Building energy data is crucial for policymaking and standard setting. But for a long time, the building industry has failed to meet the mandatory requirements set by regulations for public disclosure. Lack of detail and reliable building energy data has severely limited the national and local governments' ability to set more effective building energy efficiency standards and policies.

It must be emphasized that improvement of building energy efficiency needs to be driven not only by sound policies and rigorous standards, but also by a set of market-based financing mechanisms and tools. Both are essential and neither is optional. This report focuses on investment and financing mechanisms for energy-efficient buildings at urban scale.

Chapter 2: Financing Demand for Scaling Building Energy Efficiency in Chinese Cities

Exactly 30 years ago, China adopted its first building energy efficiency standard. Over the past three decades, China has made remarkable progress on building energy efficiency, but that achievement has been primarily funded by fiscal budget from central and local governments in the form of subsidies and incentives. Market-based financing instruments and models are almost non-existent. The Third Plenary Session of the 18th CPC National Congress, held in November 2013, called for "letting the market play a decisive role in resource allocation," thus setting a principle that a market-based financing system shall be in place to drive Chinese cities to transition to low carbon economy. China's massive urbanization and national commitment to peak its carbon emissions by 2030 or earlier have made it impossible for public finance alone to meet Chinese cities' needs for scaling energy efficiency buildings during the 13th Five Year Plan period (2016-2020). Only by encouraging private investment and policy advancement will Chinese cities be able to scale construction of green buildings and retrofitting of existing buildings.

While MOHURD has yet to release its 13th FYP on building energy efficiency, we have estimated the financing demand for promoting energy efficiency buildings and green buildings in the 13th FYP period based on relevant studies and reports[20], with particular attention given to the following areas:

- Developing high-star green buildings
- Retrofitting residential buildings in northern China
- Retrofitting residential buildings in the hot-summer-cold-winter region
- Retrofitting commercial buildings

1. Financing Demand for Greener Buildings

20. Tianjin University. "Study on the Roadmap, Gradient, Upgrade Strategy and System for the Energy Efficiency Improvement of Buildings in China." Study report sponsored by the Energy Foundation, 2015.

21. "Circular of the State Council General Office on Publishing the Action Plan on Green Buildings by NDRC and MOHURD." The State Council General Office Document [2013] No. 1, the State Council General Office, 2013.

22. Green Building Evaluation Label Web, Center for the Development of Industry, Science and Technology under MOHURD, May 2016, accessed at http://www.cngb.org.cn/.

As demonstrated by the directives issued in 2012 and 2013[17,21], the National Development and Reform Commission (NDRC), MOHURD and the Ministry of Finance are unanimous on one target: construct one billion square meters of green buildings during the 12th FYP period (2011-2015). The official website for certified green buildings shows that[22], by the end of 2015, a total of 472 million square meters of buildings had been issued green building labels. This figure actually includes projects that received green building labels before the 12th FYP period. Therefore, the total floor area of certified green buildings during the 12th FYP period is even less than half of the target. It has to be noted that the target is vague about whether the figure should only include certified new construction or not. There are no national statistics on new buildings that meet green building requirements but are not certified.

Although the Ministry of Finance announced a national subsidy policy for high-star green buildings (rated 2- and 3-star), it was never implemented, which has to some extent stymied the goal set out in the 12th FYP. Generally, greener buildings (green buildings with high-star ratings) incur higher incremental greening cost, making large-scale implementation of greener buildings particularly challenging without significant financing support from additional sources.

During the 13th FYP period, China will add about 2.116 billion square meters of commercial buildings and 6.689 billion square meters of residential buildings. According to regulations[21], commercial buildings above 20,000 square meters, government-funded buildings and affordable housing must at least meet the one-star requirements.

We estimate that, during the 13th FYP period, half of new public buildings and residential buildings will be constructed as green buildings, and that 1-star, 2-star and 3-star green buildings respectively will account for 30%, 40% and 30% of the total. Because 1-star green buildings have negligible incremental cost, incremental financing is only needed for 2-star and 3-star green buildings, which is at least RMB 224.8 billion (USD 34.52 billion) shown in Table 3.

	Gross Floor Area in the 13th FYP period (100 million m²)	% share	Floor Area of new green buildings (100 million m²)	2-Star green buildings (40%)		3-Star green buildings (30%)		Total (100 million yuan)
				Unit Cost	Cost (100 million m²)	Unit Cost	Cost (100 million m²)	
Commercial buildings	21.16	50%	10.58	RMB 136.42 /m²	577.33	RMB 163.23 /m²	518.09	1,095.42
Residential buildings	66.89	50%	33.44	RMB 35.18 /m²	470.57	RMB 67.98 /m²	681.98	1,152.55
Total					1,047.9		1,200.07	**2,248**

Table 3: Financing Demand for Greener Buildings during the 13th FYP Period

2. Financing Demand for Retrofitting Residential Buildings in Northern China

China's building energy efficiency program was first launched in northern cities where district heating dominates. This is the region where the residential building efficiency program has achieved the most success. During the 12th FYP period, this region retrofitted residential buildings more than originally planned thanks largely to the incentives provided by central and local governments. In fact, subsidies from central, provincial and municipal governments covered at least 70 to 80 percent of the retrofitting costs, and market-based financing mechanisms remained absent. For example, in 2015, Qingdao[23] carried out energy retrofits for its historical urban districts at an estimated cost of RMB 260 per square meter (USD 42). The central, municipal and district governments each contributed RMB 45 (USD 7), adding up to RMB 135 (USD 22). Additionally, the municipal and district governments further offered a five-year bonus based on energy savings after retrofitting. Each household actually paid RMB 60 (USD 10) per square meter for the retrofit, amounting to only 23 percent of the total costs. Return on investment was not the major concern, and allocation of public funds for residential building retrofitting was often justified by improvement of public satisfaction and social stability.

To date, the central government has not specified an energy efficiency target for residential building retrofits. Rather, it has only established the technical means for carrying out residential building retrofits and has been providing subsidies solely on that basis. Consequently, both the retrofitting costs and the resultant energy savings vary by building and city, and most retrofit results fell short of the requirements set by current national energy standards for new residential buildings. A few residential district retrofitting projects further attempted the green retrofitting, which required enhanced water conservation, utilization of renewable energy and environmental improvement on top of energy savings, incurring additional green costs.

We divide the northern heating region into two categories, the first category includes Beijing, Tianjin and Jilin Province; they either have a highly developed economy or are most proactive in retrofit projects. During the 13th FYP period, these cities and provinces should be the first to green retrofit residential buildings, and the average cost for greening residential buildings is about RMB 800 per square meter (USD 123). We estimate that 200 million square meters of residential buildings can be greened during the 13th FYP period. The

23. "Three million square meters of old residential compound is received policy subsidies for wall insulation retrofits." Sina Real Estate, Oct 2015, accessed at http://news.dichan.sina.com.cn/2015/10/10/1123924.

second category includes those provinces that are not in the first category. 580 million square meters of residential buildings in these provinces must be retrofitted to meet the national building efficiency standard, with an average cost of about RMB 400 per square meter (USD 61.5), and another 150 million square meters can be green retrofitted. Therefore, the total financing demand (Table 4) for greening and retrofitting residential buildings in northern China is about RMB 512 billion (USD 78.62 billion).

	Category One (Beijing, Tianjin, Jilin Province)	Category Two (all other provinces in northern China)
Target	Green retrofitting	Meet existing 65% energy efficiency standard
Cost	RMB 800/m^2	RMB 400/m^2
Floor Area	350 million square meters	580 million square meters
Subtotal	RMB 280 billion	RMB 232 billion
Total	**RMB 512 billion**	

Table 4: Financing Demand for Retrofitting and Greening Residential Buildings in Northern China during the 13th FYP Period

3. Financing Demand for Retrofitting Residential Buildings in the Hot-Summer and Cold-Winter Zone

The hot-summer and cold-winter zone mainly refers to the regions along the middle and lower reaches of the Yangtze River, where the climate alternates between bitter winters and scorching summers. The perceived temperature swings even more wildly between the two extremes due to the chronic high humidity in the regions. Building energy consumption from the hot-summer and cold-winter zone has not been incorporated into China's national policy on energy conservation, because historically residential buildings within the zone had no district heating and air conditioning, thus considered to be the regions with very low energy consumption from buildings. However, the indoor environment of residential buildings in this zone is extremely harsh with temperatures sometimes dropping below zero degrees Celsius in the winter and reaching above 40 degrees Celsius in the summer. Compounded by high humidity, the comfort level is extremely poor. It is fair to say that the historical low energy consumption in these regions was achieved at the expense of occupant health and comfort.

Since China's economy took off, these regions have become some of the most vibrant in China. There have been frequent public outcries for district heating systems like those in northern China. As the municipal infrastructure is not equipped to supply such amenity, residents in the region have turned to various types of heating appliances to improve indoor comfort. The use of air conditioners is even more prevalent, causing the grid to regularly hit higher peak load during summer.

One study [24] warns that, assuming the current disorderly situation persists, heating-related energy use in winter will rise in the hot-summer and cold-winter zone, possibly to 67 million tonnes of coal equivalent by 2020. If this estimate is accurate, it means that the energy savings achievement made by building retrofits in northern China will be largely cancelled out by the rising energy use in the south. Therefore, priority should also be given to building retrofits in the hot-summer and cold-winter zone during the 13th FYP period in order to curb the increasing energy usage.

Retrofit projects for residential buildings in the hot-summer and cold-winter zone lag behind their northern counterparts by as much as one FYP period. Between 2012 and 2015, 50.9 million square meters of residential buildings in these regions were retrofitted, slightly surpassing the target of 50 million square meters set by the 12th FYP and less than 10 percent of the retrofitted area in northern China during the same period. If the pace of retrofitting in northern China can be replicated in this zone and adequate policy and financing support are in place, it is reasonable to believe that building retrofit in the hot-summer and cold-winter zone will experience an explosive growth during the 13th FYP period,

We assume that the retrofitted area of residential buildings in the hot-summer and cold-winter zone during the 13th FYP period will increase seven times, to 350 million square meters. If 40 percent of these retrofitted buildings reach the 50 percent energy efficiency standard, 30 percent reach the 65 percent efficiency standard, and the remaining 30 percent meet the standard for green buildings, the total financing demand will be around RMB 138.2 billion (USD 21.22 billion) (Table 5).

24. Building Energy Conservation Research Center, Tsinghua University. "Study on the System of Suitable Heating Technologies for the Urban Housings in the Yangtze River Basin." Study report sponsored by the Energy Foundation, 2014.

	Share	Floor Area	Unit Cost	Financing Demand
30-50% energy savings	40%	140 million m^2	RMB 200/m^2	RMB 28 billion
65% energy savings	30%	105 million m^2	RMB 350/m^2	RMB 36.7 billion
Greening	30%	105 million m^2	RMB 700/m^2	RMB 73.5 billion
Total				**RMB 138.2 billion**

Table 5: Financing Demand for Retrofitting and Greening Residential Buildings in the Hot-Summer-Cold-Winter Zone during the 13th FYP Period

4. Financing Demand for Retrofitting Public Buildings

The initiative of retrofitting public buildings began midway through the 12th FYP period, completing 116 million square meters by the end of 2015. Public buildings have tremendous energy saving potential as they consume eight to ten times more energy per unit of floor area versus residential buildings. Currently, retrofit projects for public buildings are only aiming for an efficiency improvement of 10 to 20 percent, meaning retrofitted public buildings still fall short of current national energy efficiency standards for public buildings. In the 13th FYP period, more investment should be steered to retrofits of public buildings to further raise their efficiency level. Additionally, retrofitting should be extended to enhance performance in water conservation and utilize renewable energy, further reducing the carbon footprint from public building operations.

Assuming that retrofits will be completed for 15 percent of existing public buildings in the 13th FYP period, which is 800 million square meters, and that 30 percent of this total will meet the 50 percent energy efficiency standard, 40 percent achieve the 62 percent energy efficiency standard, and the remaining 30 percent meet the green building standard, then the total investment needs will amount to RMB 776 billion (USD 119.2 billion).

	Share	Area	Unit Cost	Financing Demand
50% energy savings	30%	240 million m^2	600 yuan/m^2	RMB 144 billion
62% energy savings	40%	320 million m^2	1,000 yuan/m^2	RMB 320 billion
Greening	30%	240 million m^2	1,300 yuan/m^2	RMB 312 billion
		Total		**RMB 776 billion**

Table 6: Financing Demand for Retrofitting and Greening Public Buildings during the 13th FYP Period

5. Total Financing Demand for Scaling Building Energy Efficiency during the 13th FYP Period

As Figure 9 shows, scaling building energy efficiency in Chinese cities will require an investment of RMB 1.65 trillion (USD 250 billion) during the 13th FYP period. New green buildings rated two-star or above will need RMB 224.8 billion (USD 34.5 billion). RMB 512 billion (USD 78.6 billion) will be needed for retrofitting residential buildings in northern China. Retrofitting residential buildings in the hot-summer and cold-winter zone will require investment of RMB 138.2 billion (USD 21.2 billion). Another RMB 776 billion (USD 119 billion) is necessary for retrofitting public buildings.

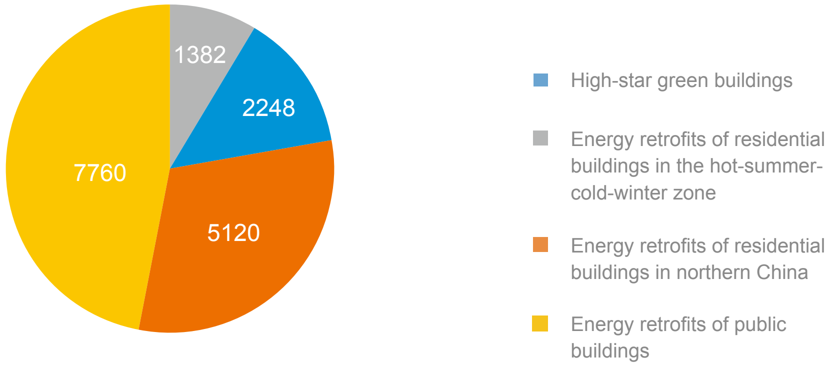


Fig. 9: Financing Demand for Building Energy Efficiency during the 13th FYP Period (in RMB 100 million)

6. Financing Gap

From the 11th to 12th FYP period, the central government steadily ramped up its funding support for building efficiency projects. While investment by the central government varied year by year, the average annual figure was between RMB 7 billion to 9 billion (USD 1.1 - 1.4 billion) during the 12th FYP period. Combined with the 1 to 1 matching funds from various levels of local government, fiscal investment in building energy efficiency amounted to an average of RMB 20 billion (USD 3.2 billion) at most, or a total of RMB 100 billion (USD 15.9 billion) for a span of FYP.

Even if the Chinese government increases its investment in building efficiency programs by 20% during the 13th FYP period, the total investment will only come to RMB 120 billion (USD 18.4 billion), or 7.3% of the total financing demand we have estimated as above. Therefore, the financing gap is going to be RMB 1.53 trillion (USD 0.24 trillion) in the next five years. Chinese cities will need to attract private capital to invest in urban building efficiency programs in order to make a transition to low-carbon cities.

7. Financing Risks

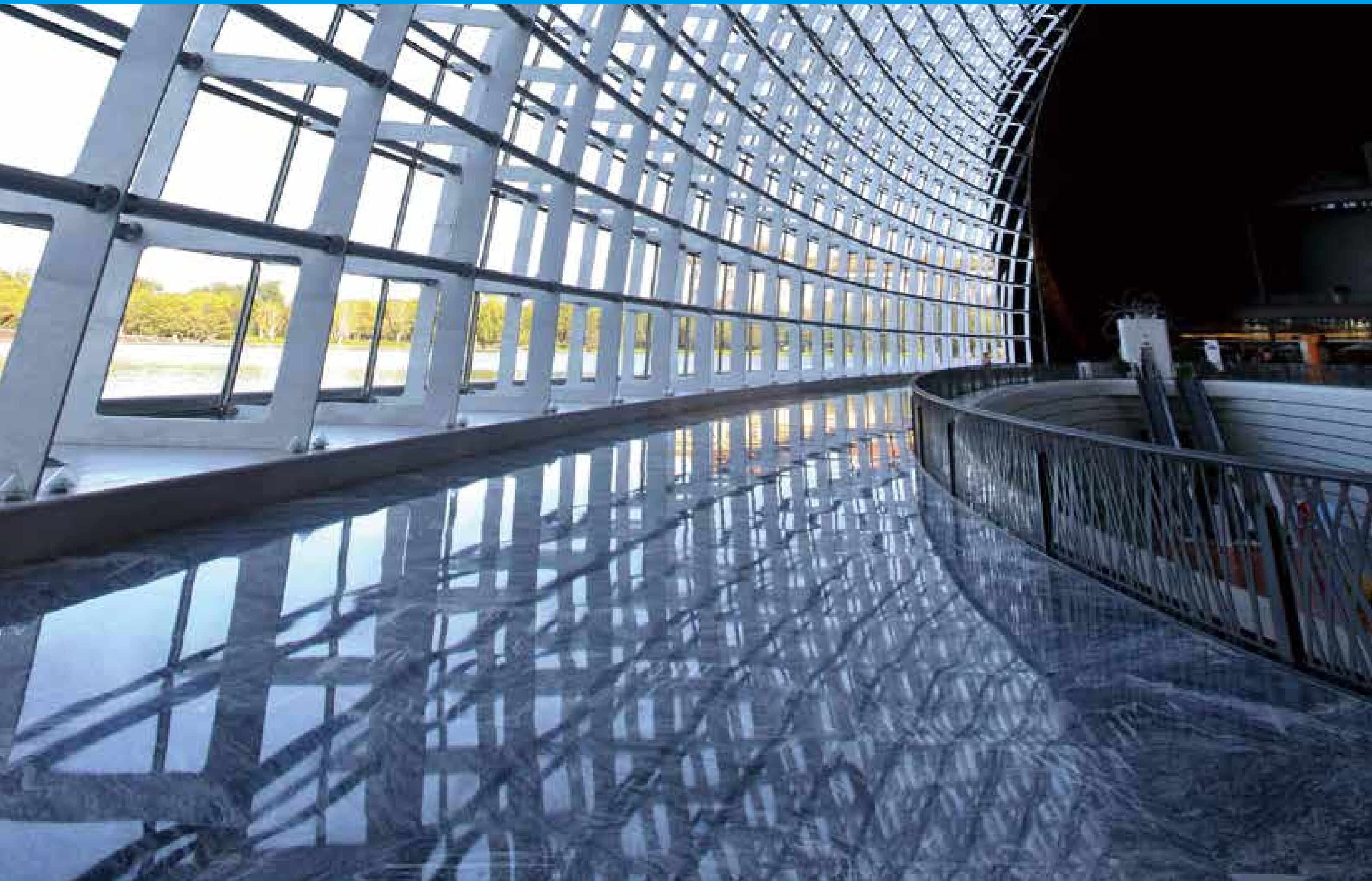
Real estate developers, energy service companies and district heating utility companies usually have the greatest financing needs when participating in urban-scale building efficiency programs. And in those economically developed cities, when they treat the energy retrofits of residential districts as social welfare projects, municipal governments will also want to finance the projects. Financing for high-star green buildings and existing building retrofits involve uncertain risks, most of which are related to whether the resulting energy savings can justify the incremental or retrofitting costs, and how long is the return on investment. In addition, most energy service companies are asset-light companies without sufficient amount of collateral to take out loans from banks. Furthermore, financial professionals are often unfamiliar with the characteristics of the building energy efficiency field, and traditional investment and financing tools are not positioned to address the specific financing dilemmas and challenges confronting the building efficiency industry. What is urgently needed is a set of financing instruments co-developed by building energy professionals and financial professionals. Table 7 below summarizes specific risks and mitigation measures.

Risk	Description	Mitigation Measure
Market risks	• Property owners are reluctant to retrofit and market demand is weak; • Sluggish demand for high-star green buildings; • Limited energy savings from retrofitting one building, making the payback period very long.	• Enhance public disclosure of building energy use, and demonstrate economic benefits of energy-efficient buildings; • Consider legislation to mandate retrofit of inefficient buildings; • Reform energy pricing mechanism to force owners to retrofit inefficient properties; • Offer appropriate subsidies to high-star green buildings and attract private capital; • Implement large-scale building retrofit projects to aggregate the potential energy savings, so as to give investment a more appealing return profile and to reduce the risks of individual building projects.
Credit risks	• Inadequate credit rating of energy service companies, thus denying access to loans; • Contract cannot be performed due to change of property owners; • Disagreement on the amount of energy savings resulted from retrofit; • Energy savings promised by energy service companies did not materialize; • Green level promised by real estate developers for green buildings did not materialize.	• Introduce a green insurance credit enhancement mechanism; • Enhance the standardization and legal force of retrofit contract; • Establish a standard for verification of energy savings.
Liquidity risks	• Energy service companies need to advance the retrofit costs, resulting in high debt ratio and insufficient cash flow; • Retrofit funds cannot be raised at a reasonable cost in the market.	• Prioritize building efficiency projects in green finance schemes and implement preferential lending rates; • Capital injection by green funds through equity investment and exit after an agreed period.
Sector risks	• Low capabilities of energy service companies; • Lack of third-party evaluation of green buildings; • Conflict of interest with green building evaluation agencies who also provide green building consulting services.	• Promote market competition; • Give preferential financing policies to energy service companies with superior performance; • Eliminate the monopoly in the green building evaluation sector, create an independent evaluation mechanism and strengthen market competition; • Strictly separate green building consulting services from evaluation agencies.
Policy risks	• Payback period is long and there is no long-term policy support; • Policies have poor continuity and are not implementable.	• Formulate medium- and long-term building efficiency policies and a roadmap to achieving zero-energy buildings; • Provide fiscal incentives to R&D of building efficiency technologies and products.
Financial risks	• Long payback period gives rise to interest rate risks; • Foreign capital investment is exposed to foreign exchange rate risks.	• Explore the collateralization and securitization of future energy savings; • Leverage financial instruments such as forex futures to reduce exchange rate risks.
Environmental risks	• Adverse environmental impact from construction noise and dust.	• Incorporate environmental assessment of construction projects into the tendering documents and strictly enforce environmental monitoring.

Table 7: Risks in Financing Urban-scale Energy-Efficient Buildings and Mitigation Measures

Chapter 3: Existing Financing Models for Urban Building Efficiency Projects

China's present shortage of financing channels and tools to support large-scale building efficiency projects in its cities – a symptom of the absence of a mature investment and financing marketplace – has become the largest roadblock for Chinese cities looking to make the low-carbon transition through aggressive development of greener buildings and extensive energy retrofit of existing city districts. At present, large scale building energy retrofit projects are subsidized by central and local governments, plus a smattering of green loans from foreign governments or intergovernmental banks, exposing the dearth of choice in source of funding and lack of innovative financing tools. Nevertheless, it is encouraging that some Chinese cities have conducted large-scale building retrofits utilizing the above limited funding sources, and this chapter summarizes and analyzes the financing models of some representative projects.



1. Energy Performance Contracting, the Basic Market-based Model for Retrofit Projects

25. "Interim Measures for the Management of Fiscal Incentive Fund for Energy Performance Contracting." Cai Jian [2010]

Energy Performance Contracting (EPC) or Energy Management Contracting (EMC) is, at present, the most popular market-based model used for retrofitting a single building. In this model, all retrofitting costs are advanced by energy service companies (ESCOs). The energy savings gained from the retrofitted building will be shared with the ESCO on an annual basis over the term of the contract. More specifically, there are several EPC models in China: shared savings, energy management outsourcing, guaranteed savings, finance leasing, and hybrids of the above.

Originated in the United States, EPC has been successfully applied in retrofitting federal office buildings. In China, by contrast, the most successful EPC has been found in industrial retrofits because industrial projects enjoy a large savings potential, high return on investment, short payback periods and a relatively easy financing process. In comparison, single-building retrofit projects save far less energy, incur higher transaction costs, and the energy savings are often hard to quantify. Additionally, the longer EPC contract terms for building retrofits often mean a higher default risk. ESCOs on building retrofits have great difficulty in securing bank loans.

The central government set up an incentive fund[25] in 2010 to promote EPC and the development of the energy service industry. For EPC-based retrofit projects, the central government awarded RMB 240 (USD 35.2) per tonne of coal equivalent saved, and local governments matched the incentive with no less than RMB 60 (USD 8.8) per tonne of coal equivalent saved. The effectiveness of these incentive policies, however, was diminished by the rigorous qualification approval, strict filing requirements, and time-consuming application processes. As a result, building retrofit projects received less than 10 percent of the incentive fund. In May 2015, the State Council cancelled the EPC incentive fund, marking the end of these incentive policies.

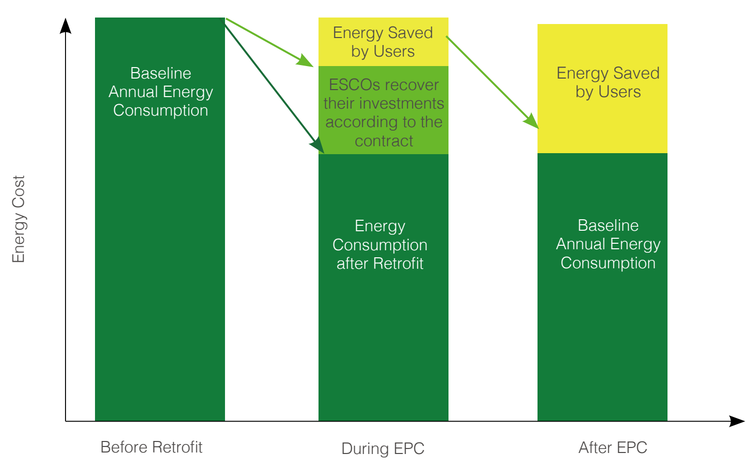


Fig. 10: The EPC Model

2. The Tonghua County Program: Financed by Government Credit-backed Loans

Retrofitting residential buildings in northern China has always been a priority in urban retrofitting plans due to the fact that space heating in this region accounts for 40 percent of the total energy consumed by buildings in China. Moreover, because 90 percent of space heating is supplied by coal-fired power plants, air quality in northern China worsens immediately whenever district heating begins. After almost eight years of continuous retrofitting efforts, coupled with higher standards for new residential buildings, energy intensity for heating in this region has declined considerably (Figure 11).

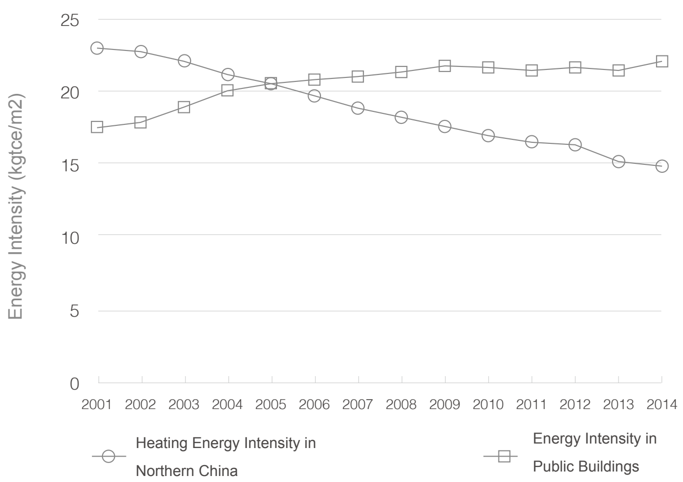


Fig. 11: Comparison of Energy Intensity for Heating in Northern China and Public Buildings (2001-2014)[2]

Located in southeastern Jilin province, Tonghua has a population of 57,600 and an urban area of 4 square kilometers. Before the retrofit program began, the county had 388 inefficient buildings, including 1.3 million square meters of residential buildings and 340,000 square meters of public buildings. A central coal-fired heating system was in service for the entire urban area. From 2009 to 2011, Tonghua completed retrofitting and installing heating meters for all 1.64 million square meters of existing buildings. After the energy retrofits, room temperature in households during the heating season has risen by 3.5 degrees Celsius on average, and energy consumption has fallen by 13.7 kg of standard coal equivalent per square meter of heating, saving 20,000 tonnes of coal equivalent each year. The overall energy savings reached 40 percent.

The entire retrofit project in Tonghua cost an estimated RMB 181.89 million (USD 27.6 million), which was funded by an inclusive financing method that taps into various funding sources, including the national building retrofit subsidy fund, matching funds from local governments, and funds raised by district heating companies and residents who would benefit from the project. Specifically, the central government provided RMB 74.18 million (USD 11.25 million) from the retrofit subsidy fund. The Finance Bureau of Tonghua, after negotiating

No. 249, NDRC and Ministry of Finance, 2010.

26. This diagram is courtesy of Xin Jianan, senior program associate of China Buildings Program at the Energy Foundation.

with Jilin Provincial Trust Company Limited, used the county government credit to secure a loan of RMB 51 million (USD 7.74 million) as the local government's matching subsidy. The remaining funding gap was filled by the district heating companies and residents.

Previously, residents paid heating bills based on the square footage of homes no matter how much heating they actually consumed. The heating reform concurrently launched with the retrofit project enabled the district heating companies to charge households by how much heating they consumed. Therefore the district heating companies were enthusiastic in participating in the retrofit program. These companies appropriated RMB 12.37 million (USD 1.88 million) from their own accounts and took out RMB 10 million (USD 1.5 million) in secured loans from banks. The residents contributed RMB 7.34 million (USD 1.1 million) for installing efficient windows. The remaining funding gap of RMB 27 million (USD 4.1 million) was covered by property owners of commercial buildings.

Tonghua completed the energy retrofit project in just two years. Although as much as 70 percent of the investment was still financed by subsidies from the central and local governments, this project is a landmark large-scale retrofit program for its heating reform, a wide array of financing channels, and enthusiastic participation by both heating companies and residents.

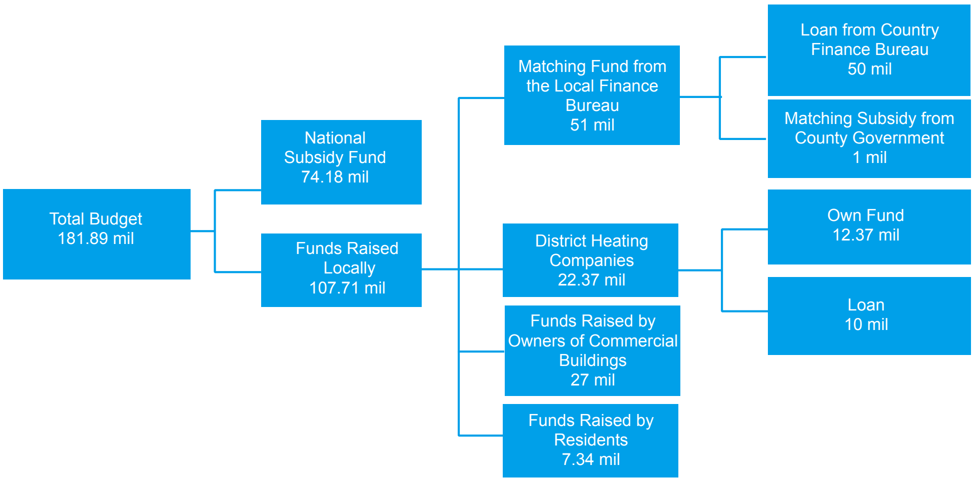


Fig. 12: Financing Model for Retrofit Project in Tonghua[26]

3. The Chongqing Program: Financed by Bank Credit and Implemented by a General Contractor

Commercial buildings have high energy intensity and substantial savings potential for energy retrofit. However, ESCOs need to demonstrate robust financing and comprehensive retrofitting capacity. In China, the city of Chongqing has always been a pioneer in promoting building energy efficiency. Since 2011, the city has been exploring large-scale retrofit of commercial buildings, covering office buildings, shopping malls, hospitals, hotels and schools. The goal was to retrofit four million square meters of commercial buildings and cut energy use per unit of floor area by 20 percent or more.

Chongqing chose to partner with the Tongfang Company Limited, a listed company with an established reputation in the field of building efficiency that took out a loan of RMB 2 billion (USD 0.3 billion) from the Bank of Chongqing. The central government provided an incentive of RMB 20 (USD 3) per square meter for commercial buildings that lowered energy intensity by 20 percent after retrofit. The Municipal Finance Bureau offered its matching incentive in the form of a differential mechanism: RMB 15/m^2 (USD 2.3) for retrofit projects that achieved a 20-25 percent of reduction in energy intensity, and RMB 20/m^2 (USD 3) or those cutting energy intensity by over 25 percent.

Tongfang served as the general contractor for the entire retrofit program and subcontracted the actual retrofitting work to its subsidiary Technovator International Limited. To cultivate the local energy service market, Technovator hand-picked 30 or so energy service start-ups, transferred to them its energy and retrofitting technologies as well as practical experience, with a plan to merge or acquire them after they grew mature. Moreover, Technovator shared 20 percent of the energy savings and government incentives with property owners to encourage their active participation in energy retrofits. The sharing of energy savings ranged from five to seven years.

By the end of 2015, Chongqing had successfully retrofitted 107 public buildings, totaling 4.4 million square meters. All buildings passed the inspection by the Ministry of Finance and MOHURD. A national incentive fund of RMB 88 million (USD 14.2 million) was accordingly awarded, calculated on the basis of RMB 20/m^2 (USD 3) in addition to the annual revenue of RMB 40 million (USD 6.45 million) from shared energy savings. Encouraged by the success of its large-scale retrofitting model (Figure 13) for commercial buildings, Chongqing decided in 2015 to retrofit another 3.5 million square meters of commercial buildings.

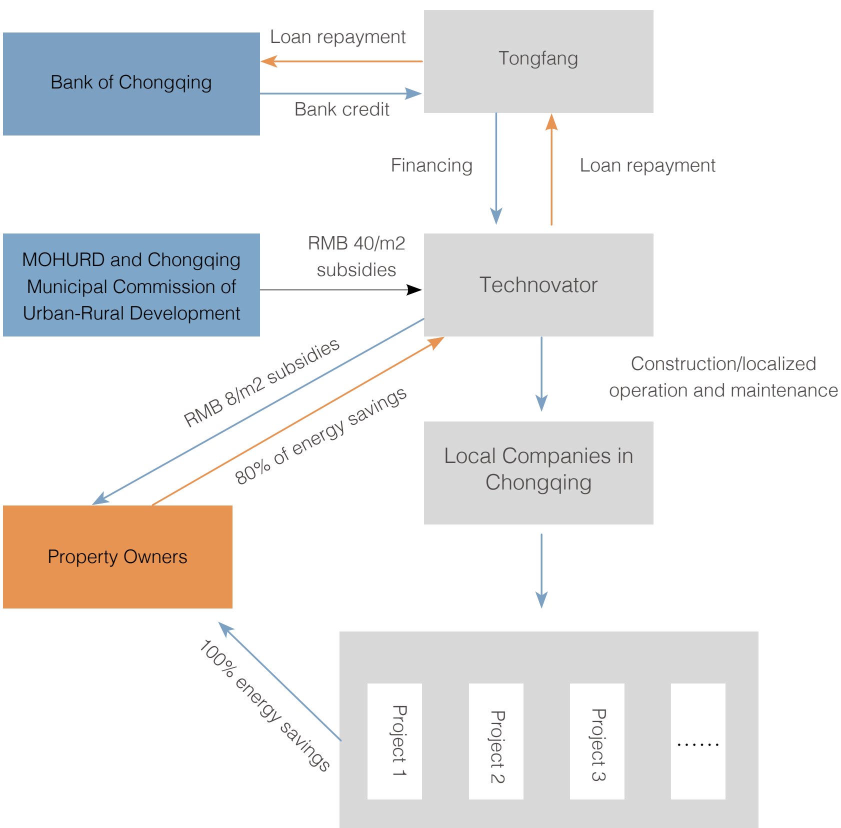


Fig. 13: Financing Model for the Public Building Retrofit Project in Chongqing

The success of the Chongqing retrofit project suggests the following key issues for urban-scale building retrofits:

- **Bank Credit:** The entire 4-million-square-meter retrofit project was undertaken by a single company, Tongfang, who gained considerable profits from aggregated energy savings. This earning potential, coupled with the creditworthiness of Tongfang as a listed company, ensured Tongfang to obtain bank credit with ease. Moreover, compared with loans, bank credit encourages more efficient utilization of funds and can therefore boost the overall returns.

- **Profit Sharing:** To encourage property owners to participate in the project, Tongfang offered them 20 percent of the energy savings and government subsidies.

- **Technological Strength:** Tongfang is highly experienced in managing multiple building retrofit projects, with good government relation and a vast repository of building energy retrofit technologies. As a result, the company enjoys a commanding position when choosing buildings with the highest energy savings potential and negotiating for lower construction costs.

- **Nuturing Local Companies:** Tongfang's partnership with more than 30 local ESCOs not only accelerated the signing of qualified buildings for retrofits but also shortened the project period.

4. The Changning District Program: Funded by a Loan from the World Bank

Located in central Shanghai, the Changning District features a predominant service industry that is the heart of the local economy. Correspondingly, the overwhelming majority of energy consumption and carbon emissions comes from public and residential buildings. This is illustrated by Figure 7, which shows the similarity between Changning and New York City in terms of their carbon emission profile – that buildings account for over 75 percent of total carbon emissions. The Changning district government elevated the retrofit of existing buildings to the top of its agenda when it planned for the low-carbon demonstration area. At the same time, the district also started optimizing district traffic, demonstrating ultra-low energy buildings and embracing distributed renewable energy.

Because the low-carbon transition of Changning focused on large-scale building retrofits and the transition model could be replicable in other districts of Shanghai, the World Bank decided to offer a loan of USD 100 million to the district, along with a grant of USD 4.345 million from the Global Environment Facility. Two local banks serving as the World Bank's implementing agencies (Shanghai Pudong Development Bank and Bank of Shanghai) would provide another USD 100 million as a matching loan. The borrowing companies were required to pool together USD 46 million as matching funds. The district government of Changning was to disburse a loan of USD 5.655 million to match the grant from the Global Environment Facility. The total investment was therefore USD 256 million (RMB 1.6128 billion). The loan agreement for this project was signed on June 14, 2013 and took effect on September 6, 2013. The closing date is scheduled for December 31, 2018.

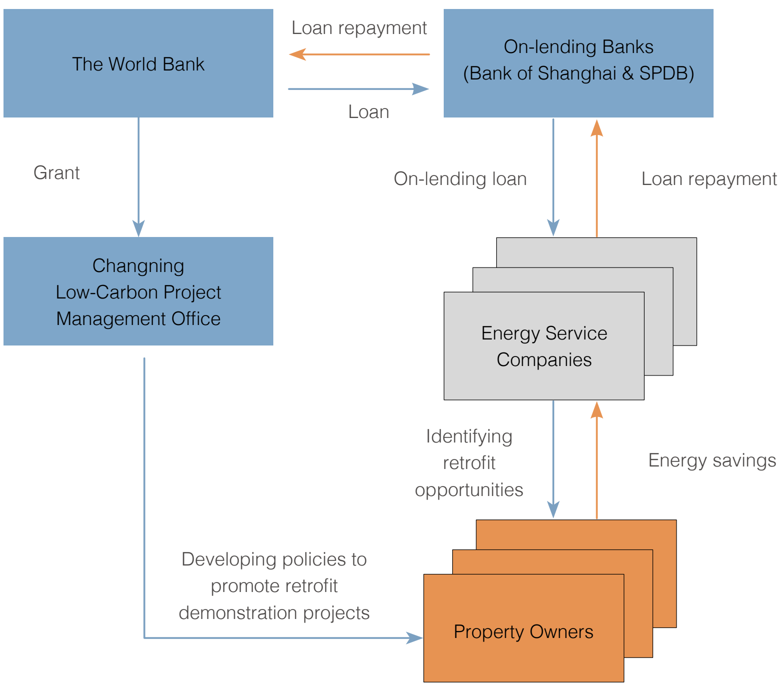


Fig. 14: Financing Model for the Retrofit Project in Changning District, Shanghai

According to information published by the Shanghai Municipal Audit Bureau[27], the project has not been progressing as planned. By the end of 2014, the two local banks had each disbursed the World Bank's loan to one company, at a combined RMB 4.61 million (USD 0.76 million). The borrowing companies only put together RMB 5.67 million (USD 0.94 million) as matching funds, and the two local banks had not made any matching loans. The total investment of the two projects was RMB 10.28 million (USD 1.7 million), representing a mere 0.66% of the planned USD 246 million (translated to RMB 1,549.8 million). According to data released by the World Bank in 2015[28], only 4% of the World Bank loan was disbursed from 2014 to the end of 2015. Given that the World Bank's loan was three years away from closing in 2018, the World Bank downgraded the rating of the overall implementation progress to "moderately unsatisfactory."

A number of factors have contributed to the slow progress of this project in Changning district:

- **Property owners have little interest in energy retrofits.** Since energy is relatively cheap in China, property owners of commercial buildings lack the motivation to improve the buildings' energy performance. This problem had been anticipated by the World Bank. In response, it requested the district government to adopt policies that would mandate owners of inefficient buildings to conduct retrofits. These policies, however, never saw the light of day due to the fact that the district government of Changning did not have legislative power, and the Shanghai municipal government had no political will to develop such policies that would have to go through the lengthy legislation process.

- **Uncompetitive on-lending rate.** The World Bank still took its conventional on-lending approach. Although the World Bank loan was

27. "Audit Result of the 2014 Financial Accounts and Implementation Status of Green Energy Schemes for Low-Carbon City Project Managed by Shanghai Changning District Low-Carbon Project Management and Development Center under World Bank Loan and Global Environmental Facility Grant", Shanghai Municipal Audit Bureau, 2015.

28. "Green Energy Schemes for Low-Carbon City in Shanghai, China – Implementation Status & Results Report." The World Bank, Public Disclosure Copy, 2016.

offered at a relatively lower interest rate, the rate customers eventually received was not that competitive in the market because the local implementing banks added profit margins to the World Bank's rate.

- **Lack of Building Energy Specialty.** The two on-lending banks did not have experts in building efficiency and therefore were not able to review and approve loan applications from EPC companies in an expeditious manner, delaying the loan approval process.

5. The Wuhan Program: Funded by a Loan from a Foreign Government

In 2006, AFD (the Agence Française de Développement) and the Hubei Construction Commission signed a cooperative agreement on a demonstration project for retrofitting government buildings and the associated financing mechanism. In 2009, Wuhan was chosen for project implementation. AFD and the Ministry of Finance then entered into a formal loan agreement in November 2011, and later in December, the project commenced aiming to retrofit 30 municipal government buildings and a city library – a total of 624,000 square meters. Per the agreement, AFD would extend a loan of 20 million euros (translated to RMB 174 million) with an interest rate of Euribor + 0.25%; and the Chinese side would provide a matching fund of RMB 26.122 million (3.96 million). The project adopted the EPC approach, whereby the energy savings generated would be shared over a period of 12 years. The principal and interest for the static investment over the 12-year period is RMB 229.4 million (USD 34.8 million), and the static returns from energy savings over the same period would be RMB 232.6 million (USD 35.3 million), generating a modest surplus. After retrofit, the overall energy saving rate is expected to reach 30 percent, with an estimate carbon emissions reduction of 15,000 metric tons and electricity savings of 1.7 MWh each year.

In 2014 when the project was in progress, it was discovered that only 15 of the originally chosen 30 government buildings were fit for energy upgrading. As a result, another 18 public buildings were added as replacement. By the end of 2014, two buildings had been retrofitted, five were in progress, and another six were going through the design, bidding and procurement process. Clearly, the overall implementation of the project was slow[29]. In May 2016, after a discussion with AFD[30], the project plan was modified to retrofitting a total of 25 government buildings, increasing the total floor area to 1.43 million square meters, and shortening the payback period from 12 to 8 years.

The most significant difference between this project and the ones in Changning and Chongqing is that the property owners in this project are all municipal government agencies. There is no need to incentivize owners to participate in retrofitting. On the other hand, it is exactly because the owners were local government agencies and the loan was granted by a foreign government that the Wuhan project had to go through a more rigorous review and approval process (Figure 15) with respect to project budgeting, documenting, implementation and supervision, making the project cycle even longer.

29. "Audit Result of the 2013 Financial Accounts and Implementation Status of AFD-Wuhan Public Building Retrofit Project." Wuhan Municipal Audit Bureau, October 2014, accessed at http://www.whaudit.gov.cn/id_4028281a4f02b8af014f02e7301501a0/news.shtml.

30. Senior Project Official Sui Hong of AFD discussed the latest project status with the research team through an email dated May 18, 2016.

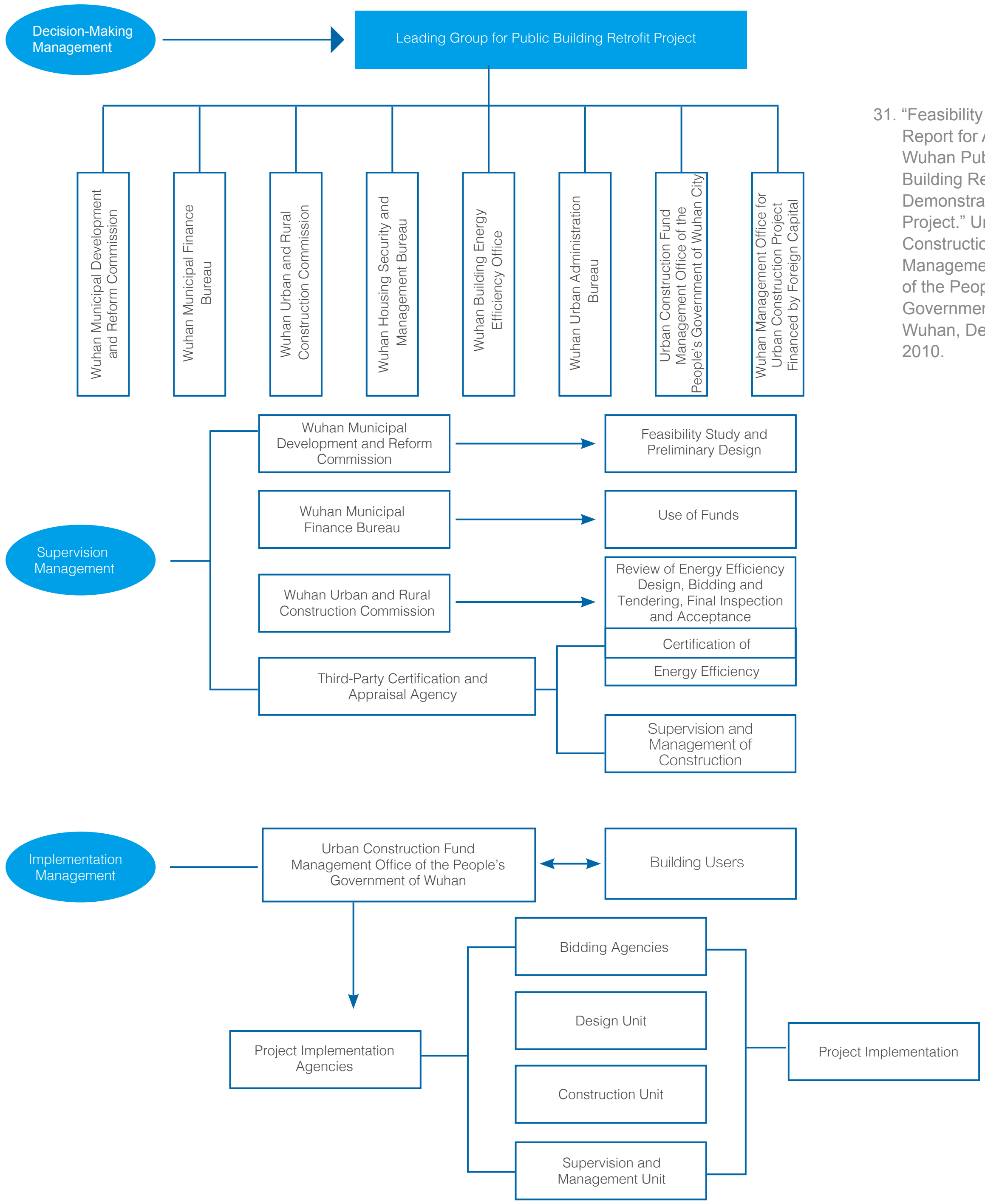


Fig. 15: Flowchart of AFD-Financed Energy Retrofit Project in Wuhan[31]

31. "Feasibility Study Report for AFD-Wuhan Public Building Retrofit Demonstration Project." Urban Construction Fund Management Office of the People's Government of Wuhan, December 2010.

The following factors have slowed down the progress of the AFD-Wuhan project:

- **Long program cycle led to foreign exchange risk.** Even though the project was financed by a French government loan, the budget plan had failed to take foreign exchange risk into account. Due to the long duration of this project, volatile exchange rates led to funding gaps in some retrofitting projects.

- **Review and approval procedure was complex and time-consuming.** The complexity of both the project's organizational structure and the required review and approval procedures has led to "incessant coordination among the parties and ever widening gaps between the project progress and the target schedule"[29]. Moreover, the laborious bidding process of AFD has also affected the construction speed to some extent. Therefore, the model of this project targeting government buildings is not replicable in large-scale commercial building retrofit projects.

- **Lack of criteria for MR&V energy savings.** The protocol of measurement, reporting and verification (MR&V) of energy savings is crucial for any building retrofit project. For projects that rely on energy savings for loan repayment and profit-sharing, uncertainty with actual energy savings, due to lack of a MR&V clause in the agreement, can negatively affect both the revenue distribution among parties and the evaluation of retrofitting projects.

6. Summary

These four large-scale building energy retrofit projects are both unique and similar. They offer valuable experiences and reveal potential pitfalls.

- **Funding availability is key.** All four projects were financed by loans or bank credit and there was hardly any involvement of private capital, proving lack of diversity in source of funds. Both the Changning project and Wuhan project were backed by foreign loans that must be repaid on time since they were sovereign-backed loans, and yet these two projects also saw the slowest progress. As a result, there was considerable uncertainty on whether all the retrofitting goals could be achieved and whether the loans could still be repaid with energy savings.

- **Market development should be valued:** Fund availability alone does not guarantee that a project can proceed as planned. Large-scale retrofit projects call for involvement of many property owners, whose different expectations and interests must be managed individually, making project development a time-consuming process. The Chongqing project deployed over 30 local ESCOs to drive project development and, by sharing government subsidies and the revenues from energy savings, incentivize property owners to participate in building retrofits. Tonghua County achieved the same goal by promoting heating reform so that district heating companies were active in developing projects. These two projects enjoyed relatively smooth progress, which probably did not occur by chance given that their contractors were also responsible for market development. In contrast, the Changning project did not set a party for market development, and the much-anticipated policies for mandating property owners to retrofit their buildings have yet to emerge, thus resulting in much slower progress.

- **Technical capacity is crucial.** Chongqing retrofitted 107 public buildings with a total of 4.4 million square meters in four years. Tonghua completed its project in two years, improving energy performance of 388 residential and public buildings, a total of 1.64 million square meters. These results have highlighted the importance of technical capacity, illustrated by Tongfang, and of multi-project management capability, demonstrated by the district heating companies in Tonghua. Both of these elements are crucial to any project aiming to retrofit urban-scale buildings.

Chapter 4:
Comprehensive Financing Solutions for Urban Building Efficiency Projects

1. Investment and Financing Approaches for Urban Building Efficiency Projects

Investment and financing approaches generally include fiscal financing, debt financing, equity financing, finance leasing, and carbon trade financing, each with its own features and scope of application. Currently, fiscal financing and debt financing are still the dominant approaches for urban building efficiency projects. Equity financing is hardly seen. Finance leasing is rarely applied to energy performance contract (EPC) projects; and carbon trade financing is expected to become a viable approach following the launch of a nationwide carbon trading market in 2017.

	Investment/Financing Tool	Application
1. Fiscal financing	Central government appropriation	Building retrofit; high-star green buildings
	Local government appropriation	Building retrofit; high-star green buildings
	Deduction and exemption of urban infrastructure surcharge	High-star green buildings
	Deduction and exemption of land transfer fees	High-star green buildings
	Refund of urban infrastructure surcharge	High-star green buildings
	Special fund for green buildings	High-star green buildings
	Special fund for efficient buildings	Building retrofit
2. Bond financing	Loans with preferential interest rates	Building retrofit; high-star green buildings
	Foreign government loans	Building retrofit
	Loans from international development financial institutions	Building retrofit; high-star green buildings
	Local government bonds	Building retrofit
	Corporate bonds	Building retrofit; high-star green buildings
	Asset-backed securities (ABS)	High-star green buildings
3. Equity financing	Public investment funds	Building retrofit
	Private investment funds	Building retrofit
	Industry investment funds	Building retrofit; high-star green buildings
4. Finance leasing	Direct lease	Building retrofit; high-star green buildings
	Sale-leaseback	Building retrofit; high-star green buildings
5. Carbon market financing	Carbon trading	Building retrofit

Table 8: Investment and Financing Approaches for Building Energy Efficiency in Cities

Aside from the standard financing tools listed in Table 8, some local governments have introduced innovative policies to promote green buildings, including:

- Fast approval channels for green projects;
- Bonus of floor area ratio (FAR) for high-star green buildings;
- Incremental gross floor area as a result of the application of green building technologies will not be factored into FAR;
- High-star green building evaluation label as a prerequisite for receiving prestigious national awards of high quality building projects, such as the Luban Prize or Guangsha Prize;
- Buildings with a high-star green building evaluation label enjoy priority treatment in national and local industry prizes and awards.

2. Credit Enhancement through Green Insurance: A Proposed Model for Scaling High-Star Green Buildings

The fizzling out of the subsidy program for green buildings announced by the Ministry of Finance in 2012 both upset and confounded the construction industry. Actually, the serious deficiencies in the current green building evaluation system (on which the subsidy program heavily relies) are deterring both subsidies from the central government and investment from the private sector. The cause of this aversion is that green evaluation results for a building are mostly based on its design drawings and may greatly diverge from the building's actual performance. This problem is not unique to the green building industry in China but represents a common challenge worldwide. Given that the green label for operations reflects actual performance and is harder to get, developers are usually only willing to get the green label for design. Some even modify the design and lower the standards after receiving the green label for the design stage. Not surprisingly, average home buyers are usually skeptical of and indifferent to a building's green features and thus unwilling to pay a premium for buildings with green labels, making it hard for developers to recoup the incremental investment in green features. Concerned with the investment return from green buildings, investors are cautious about financing green buildings at scale. And due to the lack of public confidence in evaluation institutions, the green building evaluation label has limited added value.

Figure 16 proposes a green financing mechanism that uses insurance and independent evaluation institutions to provide credit enhancement for high-star green buildings. This mechanism addresses the concerns of various stakeholders in the green building market in the following way:

1. Insurance company provides green insurance policy for high-star green buildings;
2. Developer purchases the green insurance policy for high-star green buildings and commits to constructing a green building to accomplish specified green performance;
3. By presenting the green building insurance policy, the developer receives a concessional construction loan from a bank committing to green finance;
4. The developer constructs a green building with the bank loan;
5. The developer presents the green building insurance policy to a consumer who prefers green property;
6. The consumer purchases the green property with a preferred mortgage rate from the bank;
7. After the consumer has moved into the building for one year, the third-party evaluation institution designated by the insurance company evaluates the performance of the building;

8. The third-party evaluation institution submits the evaluation result to the insurance company and is accountable to the evaluation result;

9. If the evaluated result falls short of the commitment made in the insurance policy, the insurance company will compensate the consumer and file a report with the government;

10. The government periodically subsidizes insurance premiums with already announced but not implemented subsidy funds for green buildings, without having to worry about inadvertently rewarding dishonest developers.

3. Policy Recommendations for Financing Urban-scale Energy Efficiency Buildings

While appropriate investment and financing tools are vital for scaling energy-efficienct buildings and green buildings in cities, well-designed building energy policies and enforcement mechanisms are just as critical. Financing and energy policy must go hand in hand for scaling energy-efficienct buildings so that a transition to low-carbon urbanization is possible in China.

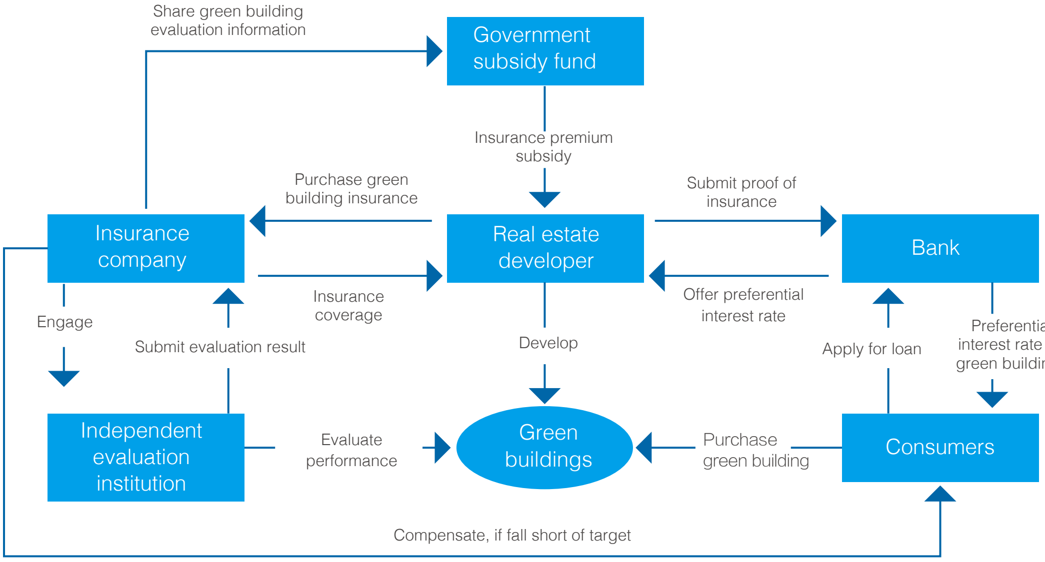


Fig. 16: Insurance-Based Credit Enhancement Mechanism for High-Star Green Buildings

This report proposes the following recommendations to spur green investment and financing mechanisms for scaling energy efficiency buildings in Chinese cities:

1. **Green building legislation.** The Energy Conservation Law should be revised to include regulation and management of green buildings. The "Regulations on Energy Conservation in Civil Buildings" should be expanded to "Regulations on Green and Energy-Efficient Civil Buildings", providing a legal basis for the promotion of green urbanization, green buildings, and green urban infrastructure.

2. **A Medium- and long-term national plan on energy-efficient buildings.** The central government should announce the building efficiency targets from the present to 2030 in order to raise expectations among various stakeholders, including local government agencies, real estate developers, construction material and component suppliers, and energy service companies. With clarified national goals, the market will invest in advanced energy efficiency technologies, products and capacities.

3. **Mandatory disclosure of building energy data.** A disclosure mechanism for building energy data is critical for creating market demand for energy-efficient buildings. Many European countries have legalized disclosure systems. Although similar provisions can be found in China's 2008 edition of Regulations on the Energy Conservation of Civil Buildings, they have never been strictly enforced.

4. **An independent third-party evaluation mechanism for green buildings.** A neutral evaluation system is essential to attracting private investment in green buildings. Strictly speaking, current green building evaluation institutions are not bona fide third-party agencies – many of them not only hold near-monopolistic market positions, but are also highly susceptible to conflict of interest from serving concurrently as the consultant to and evaluator of the same green buildings. The government has yet to establish strict supervision and punishment mechanisms for green building evaluation institutions.

5. **Concessional loans to high-star green buildings.** To encourage developers to construct more green buildings, the government should provide concessional bank loans for independently certified green buildings, and also develop policies that incentivize banks to offer preferred mortgage loans to green houses.

6. **An insurance guarantee mechanism for green buildings.** Currently, the evaluation of green buildings mainly relies on design drawings, which is not indicative of the actual green performance of the building once put into operation. As a result, the central government is reluctant to implement its already announced incentive funds for green buildings. An insurance guarantee mechanism working in tandem with an independent evaluation system will create a credit enhancement framework for green buildings, thereby attracting private investment and encouraging governments to leverage various incentives and subsidies.

7. **A compulsory insurance system for building retrofit projects.** Retrofit contracts and the benefit-sharing arrangements are sealed prior to the start of a building retrofit, even though actual energy savings can only be measured after completion of retrofit. Hence, introducing a compulsory insurance system for building efficiency ratings will help reduce the disputes between the property owner and the energy service company, protecting the rights and interests of both parties.

8. **A green building industry fund.** The promotion of green buildings will be a long-term endeavor involving the entire industry value chain from planning, design, construction, operation, to material production and technological R&D. Setting up an industry fund for green buildings is conducive to fostering and energizing every link in the green building industry chain.

9. **Municipal bonds for urban-scale building retrofits.** Currently, large-scale urban retrofit projects primarily rely on bank or government loans. The municipal governments can be permitted to back and issue bonds for scaling building retrofits.

10. **International cooperation and international green loans and funds.** The current investment quota and capital flow quota can be relaxed for qualified foreign institutional investors (QFIIs) investing in urban-scale building retrofits or green building projects in China.

Postscript

Low-carbon urbanization is critical to the China's sustainable economic transition. Since the Beijing representative office of the Paulson Institute was opened in China three years ago, sustainable urbanization has been a priority for our research team and CEO Council. We focus on economic, financial and investment areas to identify solutions and provide policy recommendations by leveraging the influence of business leaders.

Last year, the Paulson Institute published a series of research reports on energy savings and carbon reductions in cities, including *China's Next Opportunity: Sustainable Economic Transition*, *Building Energy Disclosure: How Energy Reporting for Buildings Can Reduce Costs and Improve Efficiency*, *Carbon Emissions Trading: Rolling Out a Successful Carbon Trading System*, and *Climate Change, Air Quality and the Economy: Integrating Policy for China's Economic and Environmental Prosperity*.

Investment and financing of urban-scale building energy efficiency has always been a challenge. It started earlier in Europe and the United States, which are still seeking solutions. The main questions are:

- How to invest in building energy efficiency retrofits at scale?
- How to standardize, and securitize if possible, building energy efficiency projects?
- How to improve the capacity of the financial industry to finance building energy efficiency projects?
- How to motivate owners to join building energy retrofit initiatives?
- How to truly solve the long-term problem of public disclosure of building energy data?

The importance of seeking solutions to the above challenges is obvious, however, answers are often elusive. It is important for policymakers, energy experts, financial experts and others to work together, and find innovative models and develop appropriate financial products.

We hope this report can initiate discussion on investment and financing for urban-scale building energy efficiency projects in China.

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This report is unable to cover everything relevant due to time limits. The opinions and views expressed herein may not reflect consensus of all parties, but rather are more of my preliminary understanding in the field of building energy efficiency. Further comments or input are very welcome.

Kevin Mo, Ph.D.

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