

Building energy efficiency in China rural areas: Situation, drawbacks, challenges, corresponding measures and policies



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ABSTRACT

At present, building energy consumption (BEC) accounts for about 30% of total energy consumption in China, where rural BEC (RBEC) accounts for 37% of total BEC and it still shows a trend of increase year by year. To reduce RBEC is a strategic problem in new rural construction under the premise of improving rural living standards. Firstly, authors introduced the situation of RBEC, and then figured out problems and challenges in rural building energy efficiency. Secondly, authors put forward some measures about how to reduce RBEC based on strategy of adjusting measures to local conditions, including architecture planning and design, building envelope system, renewable energy development and utilization, and daily life energy saving. Finally, based on the analysis mentioned above, authors made some suggestions on policies and standards to improve building energy efficiency. Rural building energy efficiency not only has vital significance of improving rural resident living standards and life qualities but also has important meaning to reduce energy consumption and to promote new rural construction.

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1. Introduction

At present, China is in a stage of urbanization and new rural construction, and people's living levels have been greatly improved. Meanwhile, the improvement of living quality requirements also leads to sharp increase of building energy consumption (BEC). Statistics show that BEC accounts for more than 30% of total energy consumption in China, even it takes up above 46.7% of total energy consumption if energy consumption in material production is taken into accounted. However, it still presents the fast growth tendency (Gao, 2011; Li & Yao, 2009). According to utilization of energy in China, BEC can be divided into four types: Urban residential BEC, Northern heating energy consumption, Rural BEC and public BEC (including common public buildings and large-scale public buildings) (Cai, Wu, Zhong, & Ren, 2009).

Energy consumption of each type is shown in Table 1 (National Bureau of Statistics of People's Republic of China, 2011), where commercial energy includes coal, oil, electricity and LPG, biomass energy includes straw and firewood. BEC proportions of different

types are deduced, which are shown in Fig. 1. Rural BEC is 924.6 kWh, where commercial energy is 561.5 kWh and biomass energy is 363.1 kWh. Rural BEC (including biomass energy) accounts for 39% of BEC which is higher than any other proportion. As shown in Table 1, rural buildings area is 23.8 billion m², which accounts for about 51% of total building area in China. However, the total and per unit area amount of RBEC are both higher than urban buildings.

The above data show that there is a huge potential to carry out rural building energy efficiency work in China, so it should be attached extensive attention of the whole society. In view of the national situation, a little attention has been paid. In 2012, Ministry of Housing and Urban-Rural Development (MOHURD) implemented a national standard titled Design standard for energy efficiency of rural residential buildings, which generally introduces the situation of rural BEC (MOHURD, 2013). Later, MOHURD issued "Twelfth Five-Year" building energy saving special planning, which has mentioned a bit of requirements about rural building energy efficiency.

In the long run, the work above is far from enough. Accelerating the development of rural building energy efficiency has strategic meanings to improve people's living levels, to reduce energy consumption, to improve environment quality and even to promote economy development. The following objectives are explored primarily through this article aiming to promote the development of rural building energy efficiency in China.

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Table 1
BEC in China in 2010.

Items Units	Building area Billion m ²	Commercial energy Billion kWh/year	Biomass energy Billion kWh/year	BEC Billion kWh/year	BEC (excluded biomass energy) kWh/m ²
Residential buildings	15.1	438.6	–	438.6	29.14
Northern heating zones	10.2	475.6	–	475.6	46.86
Public buildings excluded heating	8.0	487.3	–	487.3	61.14
Rural buildings excluded heating	23.8	561.5	363.1	924.6	23.71
Total	46.9	1963.0	363.1	2326.1	41.99

Note: standard coal is converted into electricity according to power generation efficiency, 1 kWh = 350 g standard coal.

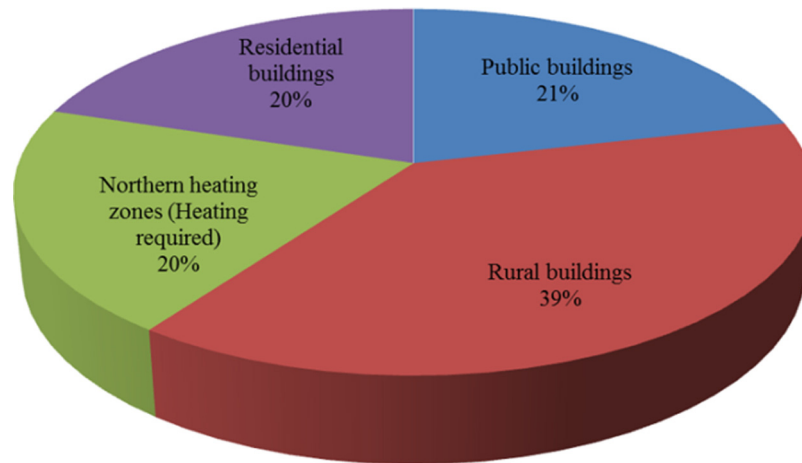


Fig. 1. The BEC proportions of different building types in China.

- Situation and features of RBEC in China have been analyzed.
- Main drawbacks and challenges in rural building energy efficiency are major issues should be addressed.
- Building energy-saving measures based on strategy of adjusting measures to local conditions are put forward.
- Some suggestions on policies and standards are made to solve the above drawbacks and challenges.

2. Situation of rural BEC

With the improvement of people's living standard, the requirements for residential quarter, including lighting, heating and refrigeration, cooking, TV and washing machine are also increasing. So the total annual rural building energy consumption has increased substantially, from 364.61 million tons of standard coal equivalent (Mtce) in 1998 to 537.98 Mtce in 2007, with an annual growth of 4.4%, as shown in Fig. 2 (Zhang, Yang, Chen, & Chen, 2009). Based on this trend, it is predicted that the total energy consumption will surpass 1000 Mtce in 2020. At the same time, the increasing economic level has increased the reliance on commercial energy. The commercial energy consumption maintains a steady growth momentum all the time, from 149.54 Mtce in 1998 to 274 Mtce in 2007, about 1.8 times with an annual growth of 7%. As for biomass energy consumption, the amount of increase is relatively less, about 50 Mtce in 10 years.

Rural BEC structures in northern areas and southern areas are different. In 2006 and 2007, Tsinghua University had carried out a survey on typical rural areas in 24 provinces and cities in China, the results are shown in Fig. 3 (Jiang, 2007). The results indicate that rural BEC in northern areas is significantly higher than southern areas, and the main reason for this is heating energy in winter in northern areas is much higher than the south, especially in the densely populated place. From Fig. 3 we can see, commercial energy plays a primary role in northern areas, which accounts for 71% of all

BEC, and ratio of commercial energy to biomass energy is about 7:3. While in northern area, biomass energy accounts for 52% and ratio of commercial energy to biomass energy is about 1:1. However, in general, biomass energy utilization ratio is still low in China rural areas.

Fig. 4 shows the change of energy consumption per unit area from 2000 to 2010 (Jiang, 2012). CE has increased significantly since 2006, but biomass energy consumption is cut in half within a decade in an alarming rate. If biomass energy still reduces in this trend, it will be completely replaced by commercial energy by 2020, so rural energy pressure will be greatly improved. Therefore, one measure to solve this problem is to take full use of renewable energy under the balanced development of increasing life quality and energy consumption.

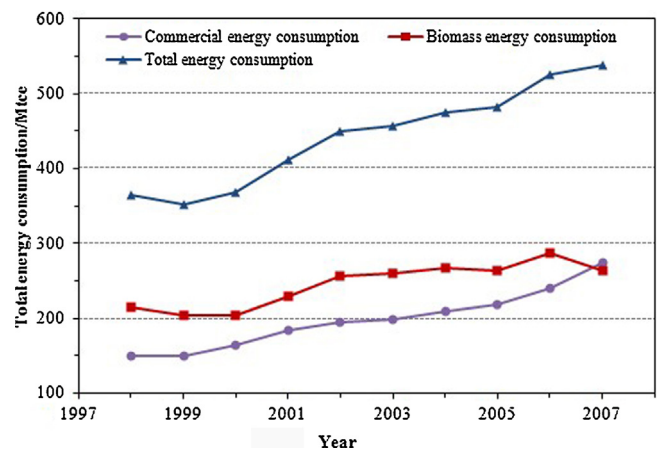


Fig. 2. Building energy consumption in China rural areas.

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