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Updates to the China Design Standard for Energy Efficiency in public buildings

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HIGHLIGHTS

- Updated China Design Standard for Energy Efficiency in Public Buildings GB 50189.
- Reviewed major changes to the standard: new and increased efficiency requirements.
- Discussed the standard's interrelations with China's other building standards.
- The standard GB 50189-2014 was compared with ASHRAE Standard 90.1-2013.
- Provided recommendations in three areas for future standard revision.

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ABSTRACT

The China Design Standard for Energy Efficiency in public buildings (GB 50189) debuted in 2005 when China completed the 10th Five-Year Plan. GB 50189-2005 played a crucial role in regulating the energy efficiency in Chinese commercial buildings. The standard was recently updated in 2014 to increase energy savings targets by 30% compared with the 2005 standard. This paper reviews the major changes to the standard, including expansion of energy efficiency coverage and more stringent efficiency requirements. The paper also discusses the interrelationship of the design standard with China's other building energy standards. Furthermore, comparisons are made with ASHRAE Standard 90.1-2013 to provide contrasting differences in efficiency requirements. Finally recommendations are provided to guide the future standard revision, focusing on three areas: (1) increasing efficiency requirements of building envelope and HVAC systems, (2) adding a whole-building performance compliance pathway and implementing a ruleset based automatic code baseline model generation in an effort to reduce the discrepancies of baseline models created by different tools and users, and (3) adding inspection and commissioning requirements to ensure building equipment and systems are installed correctly and operate as designed.

1. Introduction

The Chinese economy has been growing at nearly 10% annually for more than two decades. Along with this economy growth the national energy consumption has increased significantly. The total primary energy use in China was 3.25 billion ton coal equivalent (TCE, 1 TCE=29.39 GJ) in 2010, of which 68% was coal, 19% for petroleum, 4.4% for natural gas, and 8.6% for nuclear, hydroelectric power and wind power (NBS, 2011). China's import of petroleum is over 50% (MoLR, 2011). The availability of energy resources has emerged as a challenging issue for Chinese sustainable economic development and homeland security.

The contemporary building industry, a major engine boosting China's economic development, has added up to 60 billion square meters of new buildings since the start of economic reform in 1980s (BECRC, 2012). About 40 billion square meters of new floor space will be built in China by 2025 while urban population in 2030 will be nearly double that of 2000 (Woetzel et al., 2009). The buildings sector in China consumed 10% of the total primary energy in 1978, but has now grown to 20–25% (BECRC, 2012; Fridley, 2008; Price et al., 2011). According to the “China Road Map for Building Energy Conservation,” the total energy use in China should be controlled to under 4 billion TCE per year by 2020, with the target for the buildings sector set at 1 billion TCE per year (Peng et al., 2013).

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Nearly 20% of new construction is non-residential (commercial) buildings (Hong, 2009), including office buildings, schools, hotels, hospitals, retail shops and others. The energy consumption due to the operation of commercial buildings accounts for a significant portion of the total energy use in China, and is expected to increase by over 7% per year (Fridley, 2008; Zhou, 2007). The energy savings potential in public buildings is estimated to be about 50% by combining energy conservation measures with improved operations (Hong, 2009). In the "China Road Map for Building Energy Conservation" prescribed for non-residential buildings, targets have been set for the overall energy use intensity to be less than 65.0 kWh/(m^2 yr), with the specific criteria indicating 70 kWh/(m^2 yr) for office buildings, 40 kWh/(m^2 yr) for schools and 80 kWh/(m^2 yr) for hotels (Xiao, 2011; Yang, 2009).

Aiming for sustainable economic growth, the Chinese government and administrative entities have promoted building energy conservation measures through legislative action. Some of this legislation includes the 2007 milestone of China's law on energy conservation and two significant regulations in 2013, (1) China's 12th Five-Year Plan for the development of energy conservation, and (2) the new national standard for the energy consumption of buildings. The evolution of the related policies at the national level are shown chronologically in Fig. 1.

Along with the policies for energy conservation at a macro level, China's Ministry of Housing and Urban–Rural Development (MoHURD) developed building energy standards at a detailed level. Adopted building energy codes dating back to the 1980s included commercial (public) buildings and residential buildings (mostly apartments) in all climate zones except the temperate one. These standards defined the efficiency requirements of the building envelope, such as the minimum insulation of walls, roofs, and floors, the thermal performance of windows, as well as HVAC systems. Absent from these codes were lighting provisions, which were detailed in a separate regulation (Shui et al., 2009). The objective was to provide a prescriptive compliance path, requiring the efficient design of building components to meet standard requirements. For the building envelope, a trade-off approach allowed for the performance of opaque envelopes and windows. For the most part, the prescriptive requirements detailed in the Chinese standards are slightly less stringent than those in the United States (Mo et al., 2010; Evans et al., 2014). However, similarly to the United States (with national and state code adoption pathways), the Chinese codes are mandatory at the national level, but provide local governments with the ability to adopt more stringent standards.

For commercial buildings, MoHURD developed standard GB 50189, to prescribe minimum energy efficiency. GB, in Chinese pinyin "Guo Biao" means national standard. Derived from a hotel-based standard prescribed in the 1980s (MoC, 1993; Feng et al., 2014), GB 50189 debuted in 2005 with the goal of cutting the building energy consumption by 50% compared with baseline buildings built in 1980s. The scope of GB 50189-2005 included offices, hotels, schools and retail buildings and applied to new construction, as well as the expansion and retrofit of the existing public buildings. Serving as the major regulative vehicle since 2005, GB 50189 has successfully fulfilled its initial goals, and has significantly improved the energy performance of the public buildings in China (Hong, 2009). In 2014, MoHURD upgraded the standard to pursue further energy savings, targeting an energy reduction of 30% from 2005 baseline levels.

This paper reviews the major changes in the Standard GB 50189-2014 for public buildings in China. It discusses the relationship of the standard with China's other building energy codes, and compares the efficiency requirements with those in the United States peer standard ASHRAE 90.1-2013: Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE, 2013). Recommended areas of improvement for GB 50189 in future revisions are also suggested.

2. Methods

2.1. Introduction of the standard GB 50189-2014

China categorizes its building stock into civil buildings and industrial buildings. The civil buildings are further categorized into residential buildings and public/commercial buildings. The public buildings include office buildings, schools, hotels, hospitals, retails

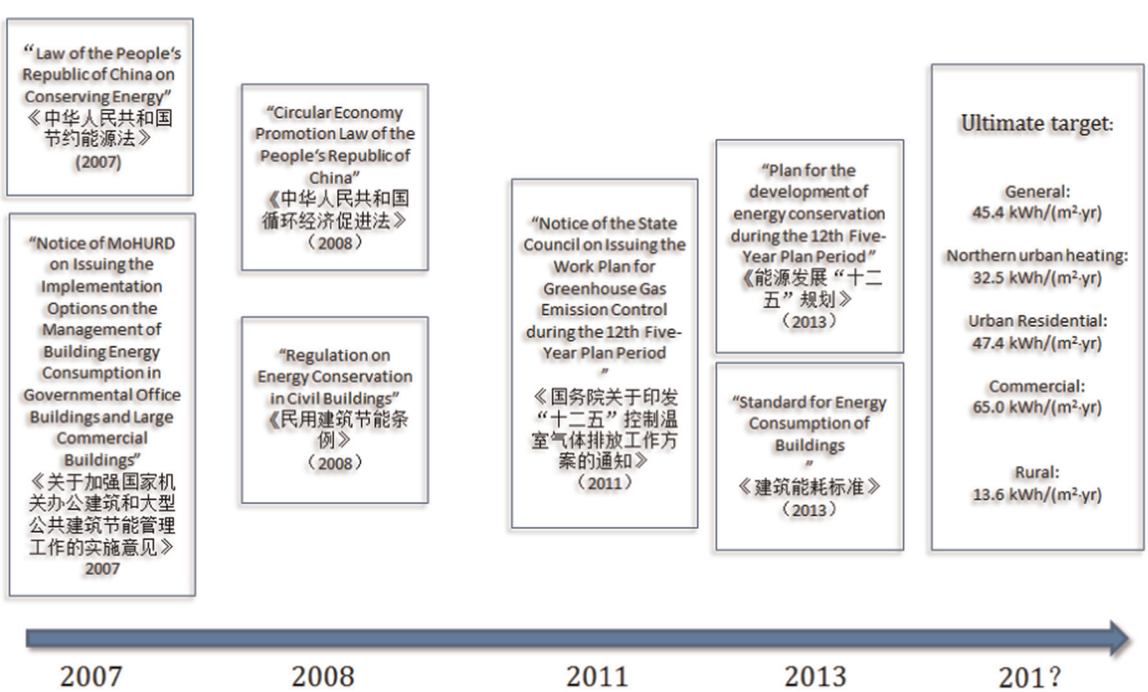

Fig. 1. Recent history of China building energy policies.