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Green building in China: Needs great promotion

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ABSTRACT

Resource depletion and environment pollution is a great challenge in the world today. As the main human living environment, building is one of the main contributor of energy consumption and pollution emission, construction industry has become the focus of energy conservation and emission reduction. China has been the world's largest carbon emitter and the world's largest energy consumer country since 2011. To solve these two issues, the promotion of green building (GB) is of great urgency. This article analyzed GB situation and challenges in China, and then pointed out some special requirements of GB. At last, authors put forward some suggestions to promote the development of GB according to current situations in China including: taking measures to enhance awareness of stakeholders, strengthening technology research and communication and establishing codes and regulations.

1. Introduction

1.1. The concept of green building

The concept of GB in China is developed from "Energy-Saving and Land-Saving Residential Building" launched by the central government in 2004. To be specific, the GB should be energy-saving, land-saving, water-saving and material-saving, environment-benign and pollution-reducing, summarized as "Four-daving and One-benign". It is defined in Chinese national standard, Evaluation Standard for Green Building, enacted in 2006 (Ministry of Construction, 2006). The so-called "green", is not the general meaning of green, but a concept or symbol. It stresses people-oriented and puts emphasis on sustainable development and environmental symbiosis to achieve harmonious coexistence among people, nature and building. GB is also known as ecological building, sustainable building, energy-saving building, etc. Its ultimate goal is low consumption and low emission, but the "low" does not mean high-tech or high investment. Actually, GB is a climate adaptative building, which requires adopting appropriate technology as much as possible to reduce energy consumption, meanwhile materials should be recycled and fully localized to achieve the lowest cost of energy and comfort.

1.2. Origin of green building

The curator of Architecture and Design Library in American National Building Museum, Giessen David, pointed out that the seeds of GB can trace back to a century or more ago. According to this, the birth of British Palace in the first world expo and Galleria Vittorio Emmanuele in Milan in the early 19th century have begun to use passive system such as roof fan and underground air cooling box to regulate indoor temperature. Early at the 20th century, Flatiron Building and New York Times Building in US have designed windows embedded into walls to reduce sunlight. Ecological system and natural environment have already been taken into consideration in early architectural design, which become the buds of green building. Until the 1960s, American architect Paola Soleri combined the two words "ecology" and "building" together, and put forward the new idea of "ecological building" (green building). In 1969, the publication of the book "Design with Nature" by American architect Ian Lennox McHarg, marked the birth of ecological architecture. Through more than half a century, GB has become a new building style that fully integrated energy-saving, building design and environmental-protection from its initial simple mode, and it is more adaptable to current situation of energy shortage, so it is a new trend of building development model.

1.3. Global actions to develop green building

To create a better environment for developing GB, countries around the world began to formulate relevant standards. The United States enacted the ASHRAE (American Society of Heating

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Refrigerating and Airconditioning Engineers) standard "Energy-saving in Design for New Building" for the first time in 1975. UK began to create GB standards as early as in 1990 (Chegut et al., 2011), and all buildings should satisfy green building criteria from 2008 in Britain (Bulkeley et al., 2011); In 2009, Britain announced Low Carbon Transition Plan, required all new buildings achieving zero-emission from 2016, all new public buildings from 2018, all office buildings from 2019 and all residential finish Smart Meters installation before 2020 (Peters, Fudge, & Sinclair, 2010). Recently, European Union promulgated a more advanced and perfect legal system in energy saving field, which is entitled Building Energy Efficiency Performance Law. The law requires all state or state-use new buildings must be close to zero energy consumption by 2020. From an early start, building energy-saving work had achieved great achievements in some developed countries. In Denmark, Heating area increased by 30% from 1972 to 1985, but the heating energy consumption decreased by 3.18 million tons of standard coal; in America, 43 billion dollars is saved in energy cost and environment management since the first energy-saving standard to 2011 (Danielski, 2012).

GB in China started relatively late. In 1996, New Urban Building Energy Efficient Standard System was issued, which is composed by the residential building energy conservation design standard. Residential Building energy conservation Design Standard of Hot Summer and Cold Winter Region was issued in 2001 and was updated in 2003. In September 2004 with the start of Green Building Innovation Award, GB in China stepped into a comprehensive developing stage. In 2006, Evaluation Standard for Green Building was officially promulgated. Evaluation Standards for Green Industrial Building and Evaluation Standards for Green Office Building started in 2009 and 2010, respectively. At present, at least 50% building energy efficiency is achieved in almost all regions of China, unlike some big cities as Beijing, Shanghai and Tianjin are executing the standards which require energy efficiency must achieve at least 65%, while Beijing is executing the new goal of 75% since "12th Year Plan" (Li & Wang, 2012; National People's Congress, 2011). However, building industrialization just starts in China, and there is still a great gap comparing with foreign countries.

2. Why to develop green building

2.1. To reduce CO_2 emission

On 3rd, December 2012, the famous journal "Nature" published an authoritative scientific research report. According to the report, the global CO_2 emission has increased to record 35.6 billion tons in 2012, and the largest carbon emission countries in 2011 are: China (28%), United States (16%), European Union (11%) and India (7%). Among them, emissions of China and India in 2011 increased by 9.9% and 7.5% respectively, while United States and European Union reduced by 1.8% and 1.8% respectively (Nature Climate Chenge, 2013). China has become No.1 CO_2 emitter country in the world, surpassing U.S. in 2007 with approximately 8% more emission (IEA, 2011). According to EIA (Energy Information Administration) estimation, CO_2 emission in United States will be 5.68 billion tons in 2015, but it will be far more than this in China (EIA, 2011). In "12th five-year plan" in China, the carbon emission in 2015 is 7.89 billion tons, which is 2.21 billion tons higher than the United States, if the total energy consumption is more than 4.1 billion tons, the carbon emission gap between China and United States will be more huge. China is in great pressure.

The greatly increasing emission further expands the gap between actual emission and the goal to control global warming within 2 °C. To ensure the global warming within 2 °C, the global carbon emission must be deeply cut by 2020 (Huntingford et al., 2012). In China, it has been decided that 17 percent reduction of carbon dioxide emissions for every GDP unit should be achieved by the end of 2015(Yu & Qu, 2013), and 40–45% by 2020 further (Yi, Zou, Guo, Wang, & Wei, 2011).

Among all elements, buildings account for around half of primary energy consumption, hence CO_2 emissions, in the UK and other developed countries (Ratcliffe & Day, 2007). Building emission mainly refers to the consumption of resources and greenhouse gases produced from consumption throughout the lifecycle of buildings, so it is closely related to human daily life and work. 50% people may cause carbon-emission by using vehicle, 30% people may be involved in industrial production, but there must be more than 90% or even more people causing endless carbon-emission because of their daily life and work. So the "energy-saving" and "low-carbon" in construction are destined to become a hot topic. Study has shown that the global construction industry and its related fields caused 70% of greenhouse effect from the production of building materials to construction and use of buildings, the whole is a huge emitter of greenhouse gases (Zuo, Read, Pullen, & Shi, 2012).

2.2. To relieve the energy crisis

China is the world's largest energy consumer now. The global net primary energy consumption grew by 2.5% in 2011, and China alone contributed 71% of global energy consumption increment. In 2011, global coal consumption increased by 5.4%, China accounted for 69%. The total primary energy consumption in China has been more than that in the United States in 2011 (Global, 2012). With the fast development, more energy will be consumed in China. But the coal-dominant energy structure in China is difficult to change in a short time, and now the coal production has exceeded the scientific capacity. In the future it is difficult to satisfy the needs even all the fossial energy were gathered in the world. Outside the pressure of carbon emission, for China the bigger challenge is that the energy consumption continues to increase. Energy consumption in EU grow at a rate of 1–2% per year, and in US it has entered slight growth stage, but China's energy consumption is still growing at a rate of 5–6% per year, total energy consumption in China will be alarming under this situation.

3. Green building situation in China

3.1. Building energy consumption in China

In China, building energy consumption accounts for 46.7% of the total society energy consumption, and 60% of the carbon emission in cities comes from maintaining buildings' function (Zhang, 2010). Due to the rapid development of economy development and urbanization in recent years, about 20×10^8 m^2 building areas are completed each year, which is larger than the total area in European and American (Zhao, Zhu, & Wu, 2009). In China, about 55 kg steel will be used in each 1 m^2 building, and it is 10–25% more than developed countries; about 221.5 kg cement will be used in each 1 m^3 concrete, and it is 80 kg more than developed countries (Zhang & Gu, 2012). The existing building areas are 430×10^8 m^2 in China, 90% of them are high energy consumption construction. Compared with developed countries, the thermal isulation performance building envelope is poor, as shown in Table 1, the larger the number is, the faster heat run off. The heat transfer coefficient of all parts in China is 2–3 times higher than developed countries (RGBI, 2010). Due to poor thermal insulation of building envelope and low efficiency of heating systems, energy consumption for heating in north China is the largest component of building energy consumption (BEC), as shown in Fig. 1 (Cai, Wu, Zhong, & Ren, 2009).