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Building energy efficiency for public hospitals and healthcare facilities in China: Barriers and drivers

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ABSTRACT

Maximizing energy efficiency within HHFs (hospitals and healthcare facilities) is a major challenge in the field of energy conservation. This paper studies the key barriers to the implementation of energy-efficient technologies in China's public HHFs. For this purpose, a preliminary survey was conducted at the Beijing Municipal Health Bureau in order to assess the energy conservation efforts being made at 20 public HHFs. In the survey, a list of specific barriers to energy efficiency was created and HHF staffs were asked to rank these barriers in the order of importance. The results show that the economic incentives, appropriate technology, as well as enforceable laws and regulations are insufficiently supported by the government, have become the most significant obstacles to the improvement of energy efficiency. To remedy this, policymakers should take a multipronged approach which addresses the hospitals, projects, and technical and operating procedures in order to encourage the full participation and support of all stakeholders involved. Specifically, the government should offer multilevel economic incentives and reward policies; establish practical mandatory targets for building energy efficiency; provide demonstrable best practices in terms of the project, techniques, and operating procedures; and promote awareness of the importance of property risk management.

1. Introduction

HHFs (Hospitals and healthcare facilities) are among the most energy intensive of all commercial buildings [1], and HHFs are responsible for a substantial portion of total commercial energy consumption in China. As in most European and North American countries, hospitals in China usually consist of large buildings, which are generally recognized as the least energy-efficient public buildings [2,3]. Unlike residential and ordinary commercial buildings, HHFs are in operation around the clock and have notably higher standard requirements for ventilation, air conditioning, sterility, and the use of armamentaria, necessitating more energy consumption [4]. China is now in a period of rapid urbanization, involving substantial development of its infrastructure [5]. Due to urban agglomeration, China's HHFs, particularly in megacities such as Beijing and Shanghai, are extremely busy providing medical services not only to locals but also to people from the surrounding regions. In these megacities, there is a great need for both new HHFs and the renovation or expansion of existing HHFs. For example, the construction of 28 new hospitals around Beijing's 5th Ring Road has been incorporated into the city's development plan in order to cope with the high demand for outpatient services in the central part of the city [6]. Moreover, according to a report by the Beijing Municipal Commission of Health and Family Planning, about 50% of the city's municipal hospital buildings were constructed before 1990, when the concept of green building design had not yet been fully introduced in China. There is huge potential for improving energy efficiency in existing hospital buildings in Beijing. As hospitals account for the highest energy-consumption-per-unit floor area of all public-use buildings and their refurbishment presents great potential for energy and cost savings [3,7], it is of great importance to promote energy efficiency and sustainability in both the design and operation of China's HHFs.

Since 2006, which was the beginning of China's 11th Five-Year Plan, the government of China has paid more intention to energy saving and planning [8]. Energy conservation continues to be a national priority and local governments are also carefully

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implementing a number of policies in many sectors [9]. However, energy conservation practices are not widespread. Although substantial benefits have been obtained through energy conservation in China's large commercial buildings [10], and there have indeed been some remarkable results in several pilot projects, China's green initiative is still far from successful [11]. There are many reasons for this, including misinformation, fear of potential hidden costs and risks, limited capital, split incentives, and simply a lack of awareness of the benefits [12,13]. Some of these barriers are particular to the building sector and have numerous specific features [14–16], though the impediments vary considerably across sub-sectors [12]. Thus, it is valuable to explore the main obstacles to the implementation of sustainable practices in China's HHFs. Some have been discussed in previous studies [1,17]; however, HHFs in China's megacities have some obvious features that may present unique hindrances to energy efficiency. For example, most HHFs in China are directly supported by the government, and the decision-makers may have multiple conflicting objectives when deciding whether to implement energy-saving measures in the buildings. The operational demands faced by HHFs in China's megacities are much greater than in small cities, and renovation for improving energy efficiency is problematic given their busy schedules. Stability of operations and safety during HHF construction, renovation, and expansion are also significant concerns. Although much research and numerous case studies have proven the substantial positive impact of energy-efficient technologies on energy conservation [3,4,18,19], there has been little research systematically addressing the barriers to and drivers of energy efficiency in HHFs, distinct from other sectors in China. Focusing on a particular sector may help the government and decision-makers avoid underestimating or overestimating barriers when implementing planned energy-efficiency measures [12].

This study began with a preliminary survey at the Beijing Municipal Health Bureau in order to assess the energy conservation efforts being made at 20 public HHFs. Then current impediments to energy efficiency in HHFs were investigated through a review of the literature. A list of barriers was developed according to the particular features of both the administrative and operational circumstances of HHFs in China's megacities. In order to identify obstacles and drivers from the perspective of management, questionnaires were distributed and interviews were conducted with the managers of the construction departments of various HHFs. Taking into account China's current economic conditions and policy system, policy tools were developed for the government with the goal of promoting maximum energy efficiency within public HHFs. These recommendations may also prove valuable to the design, renovation, and operation of HHFs in other countries as well.

2. Preliminary survey of HHF energy conservation status in China

In order to understand the sustainability practices already in place in China's HHFs, a preliminary survey was conducted at the Beijing Municipal Health Bureau to investigate the energy consumption and conservation efforts of 20 public HHFs in the city. These HHFs, all supervised directly by the government, provide 50% of the medical care in the city. These 20 public HHFs included eight comprehensive hospitals (numbered S1 to S8) and 12 specialty hospitals (numbered C1 to C12) providing care in such areas as gynecology and obstetrics, pediatrics, orthopedics, oncology, neuropsychiatry, and traditional Chinese medicine. In the survey, energy consumption information on the 20 HHFs in 2013 was used for analysis.

2.1. General energy consumption status of the HHFs

Fig. 1 shows the number of beds and bed occupancy rates of the 20 HHFs in 2013. The bed occupancy rates of the HHFs were all close to or even sometimes higher than 100%, with a demanding workload being a common feature of China's public HHFs. Figs. 2 and 3 show the energy consumption rates of the 20 HHFs. Energy consumption was positively correlated with area consumption, indicating energy consumption would continue to grow along with an increase in area.

Most of the HHFs were considering expanding through renovation or new construction in order to deal with the ever-increasing workload. Survey results indicate that 12 of the HHFs were under construction or would soon start, with 0.7 million square meters incremental floor area of the HHFs, equivalent to 37% of the current stock area (1.92 million square meters). The total floor area of the 20 HHFs is expected to be 2.62 million square meters in 2020, as shown in Fig. 4. According to the regression results illustrated in Fig. 3, the incremental floor area will lead to continuous growth in energy consumption.

2.2. Energy conservation status of the HHFs

As shown in Fig. 5, about 72.7% buildings of the 20 HHFs were built prior to 1990, at a time when there were no strict regulations on energy conservation in China. The buildings providing outpatient care were usually the largest. Only 12 outpatient buildings of the 20 HHFs studied were constructed using thermal insulation, and only two outpatient buildings of the 20 were equipped with energy-saving coated glass, as shown in Fig. 6. The use of energy-saving bulbs and LED lamps was also quite uncommon (see Fig. 7), found in only one of the HHFs. Instead, fluorescent lamps were the primary method of lighting. All 20 HHFs were equipped with boilers for heat and hot water, but only eight of them were equipped with flue gas heat recovery devices. Most of the HHFs lacked sub-metering for measuring energy use in different areas and by various pieces of equipment in their buildings. Thus, it is difficult to make a lean, energy-saving management plan based on the data. Overall, however, there is great potential for increasing energy saving in the public HHFs.

3. List of barriers to building energy efficiency

In order to develop a comprehensive list of obstacles to energy efficiency within the HHFs, two steps were implemented. First, in order to form an initial list, barriers to energy efficiency in all types of buildings were investigated through a comprehensive literature review. Information was collected on as many barriers as possible

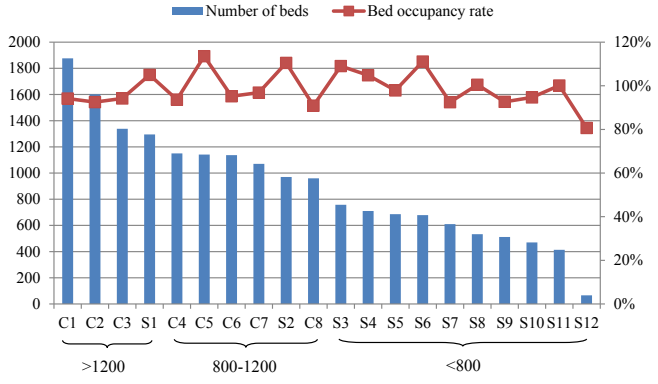

Fig. 1. Number of beds and bed occupancy rate of 20 HHFs in 2013.