



Research on the development of main policy instruments for improving building energy-efficiency



Liyin Shen ^{a, *}, Bei He ^a, Liudan Jiao ^a, Xiangnan Song ^a, Xiaoling Zhang ^b

^a School of Construction Management and Real Estate, International Research Centre for Sustainable Built Environment, Chongqing University, China

^b Department of Public Policy, City University of Hong Kong, China

ARTICLE INFO

Article history:

Received 7 January 2015
Received in revised form
24 April 2015
Accepted 24 June 2015
Available online 3 July 2015

Keywords:

Building energy-efficiency (BEE)
Policy instrument
Mandatory administration
Economic incentive
Voluntary scheme
Comprehensive analysis

ABSTRACT

Policy instrument is the key to drive improving energy-efficiency in building sectors. This paper presents the current development of BEE policy instruments by examining their practices in seven selected countries and regions. These policy instruments are classified into three groups: the mandatory administration instrument, the economic incentive instrument, and the voluntary scheme instrument. The developments of the three types of instruments are analyzed among the selected countries and regions from the perspectives of the number of policy instruments developed, the development trend and the experiences gained in developing these instruments. The study shows that different countries have made good progress in achieving better building energy-efficiency through adopting different type of policy instruments. The research reveals various experiences gained in the process of developing and implementing BEE policy instruments from various countries.

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1. Introduction

There has been a growing appeal globally for improving building energy-efficiency in pursuing the mission of sustainable development. It has been well appreciated that the increase of energy consumption has become a major factor affecting this mission. According to the report issued by the U.S. Energy Information Administration (U.S. EIA, 2013), the International Energy Outlook 2013, the world will see an increase in energy consumption, with an estimate surge of 106 quadrillion Btu between 2010 and 2020 to reach 820 quadrillion Btu by 2040. This presents a sharp energy consumption increase of 56% in the next 30 years. It is further said in this report that 85% of this increase will occur in developing countries, which is largely due to pursuing economic growth and responding to population increase. The assessment report by the International Panel on Climate Change (Bernstein et al., 2007) reveals that building sector consumes over 40% of the world's total primary energy resources and is responsible for 24% of world's CO₂ emissions. It is commonly appreciated that building sector is one of

the largest contributors to overall energy consumption in the majority of countries (Butler, 2008; Weiss et al., 2012; Saidur, 2009). Building sector's energy consumption is a major contributor affecting the environmental sustainability through producing greenhouse gas (GHG) emissions, causing climate change and consuming non-renewable resources.

In responding to these challenges brought by the increasing energy consumption, governments throughout the world have set up various energy-efficient targets. For instance, the European Union has specified an objective of reducing gas emission from greenhouses by 20% and increasing the usage of renewable energy sources by 20% during the period from 1990 to 2020 (Capros et al., 2011). China has set an energy-efficiency target in its "Twelfth Five-Year Plan" (2012), (The Central People's Government of the People's Republic of China, 2012), by which energy consumption will be reduced by 32% in comparing to that defined in its "Eleventh Five-Year Plan". Similarly, other countries have also defined various energy-efficiency targets.

Therefore more attentions have been paid on the significance of improving building energy efficiency. In arguing the effectiveness of energy policy, Clift (2007) suggested that greater efforts should be firstly contributed to energy demand reduction and energy efficiency improvement in buildings. Hamada et al. (2003) pointed out that improving building energy efficiency is important for

* Corresponding author.

E-mail addresses: shenliyin@cqu.edu.cn (L. Shen), hebei091@163.com (B. He), 396732441@qq.com (L. Jiao), songxn_ck@163.com (X. Song), xiaoling.zhang@cityu.edu.hk (X. Zhang).

protecting economic competitiveness, energy security, and environmental benefits. Popescu et al. (2012) echoed that increasing building energy-efficiency is one of the most productive methods to improve a country's energy supply security and reduce its carbon emissions. Yonezawa (2000) opined that improving building sector's energy-efficiency will create a number of benefits, including improving internal and external air quality and increasing residential conditions and life quality, if proper energy-efficiency measures are applied.

Building energy efficiency has a strong characteristic of externality, which, in economic terms, means the cost or benefit that affects a party who did not choose to incur that cost or benefit (Buchanan and Stubblebine, 1962). In fact, the prochoice of energy efficiency is in fact a public goods game (Perc et al., 2010, 2013). On the side of the main industry, there are gains to be made in profit by neglecting and obstructing the development of energy-efficiency, while in terms of the public goods, most notably the environment and the well-being of the people – these public goods could be lost due to selfish incentives of the industry which does not care for the cleaner production. In referring to the building sector, the development of energy efficiency does not only involve builders, but also other external parties such as the public and the government. For example, building developers will normally enjoy the economic interests from building developments, but environmental pollution caused by energy consumption on buildings will not be borne by the developers but by the public, and the cost for curing such pollution is usually paid by the concerned government. Therefore, the government must take a leadership in protecting environment and promoting building energy-efficiency. And government usually plays this leading role through introducing and implementing BEE policy measures (Mahmoudi et al., 2009).

As a result, improving energy efficiency in the building sector is a growing priority on the policy agendas in many countries. As appreciated by Nejat et al. (2015), there is a pragmatic shift towards the introduction and application of various BEE policy measures in both developed and developing countries. For example, Denmark became the pioneer country to apply a compulsory building energy-efficiency label program in 1997 (Dunsky et al., 2009). According to the program, all Danish buildings, whether residential or commercial, are required by law to be evaluated and rated on their energy performance. The evaluation and rating results must be shared when the buildings are on sale or lease. In Italy, municipalities have become leading actors for implementing building energy regulations codes (BERC) in order to reduce the environmental impact of new and refurbished buildings (Salvalai et al., 2015). In China, the government has been offering various economic incentives for promoting energy-efficient programs in its building sector, through its Ministry of Finance (MOF) and Ministry of Housing and Urban–Rural Development (MOHURD) (MOF, 2007; MOHURD, 2008a). The United States has issued the Energy Policy Act of 2005 (EPAct-2005), which offers tax incentives to commercial and residential building sectors for encouraging the production of energy-efficient building products and increasing the market share of these products (Meltcalf, 2007).

The proper development and selection of BEE policy measures play an important role in achieving the target of building energy efficiency. However, as different countries have different backgrounds in the perspectives of culture, economy, political systems and environmental conditions, policy measures for improving building energy-efficiency vary significantly between countries (Pérez-Lombard et al., 2009). Whilst there are cases in the world where BEE policy measures are effectively developed, the development experiences have not been examined. This paper offers an

identification and comprehensive analysis on the development of BEE policy measures from the perspective of policy instrument among the main energy-consumption countries.

2. Literature review

2.1. Research on the development of BEE policy

A number of current studies have documented the development of various BEE policies in both developed and developing countries. Some scholars focused on the identification and analysis on the development of BEE policies on a specific country. For example, Zhou et al. (2010) examined the development of implementing BEE policies from three groups in China: mandatory minimum standards for energy consumption, voluntary energy-efficiency labels and mandatory energy information labels during its 10th and 11th Five-Year Plans. And they further pointed out five significant areas where China can strengthen BEE policies, namely, enhancement of existing energy consumption standards, effective implementation of the standards, controlling on building materials that require high energy consumption, enforcement for energy retrofit, and improving motivation on the application of BEE policies. Lo (2014) conducted a critical review of policies on renewable energy and energy efficiency in the building sector in China, and identified five key policies, namely, energy codes for buildings, retrofits to existing buildings, appliance energy standards and labels, subsidies for energy-efficient and renewable energy appliances, and increasing block tariffs. Travezan et al. (2013) evaluated the performance of various policies for improving energy efficiency in the building sector in Spain. In discussing the economic incentive instruments, Shah and Phadke (2011) examined financial incentive programs in the United States for improving residential building energy-efficiency and summarized the main incentive programs into eight groups. They found that financial incentive measures are the most effective policy measures used to restrain the growth of energy demand in the building sector.

Other scholars focused on the identification and comparison of BEE policy measures between various countries. For example, Noailly (2012) analyzed empirically the performance of typical types of building energy efficiency policies adopted among seven European countries during the period of 1989–2004. The study by Wiel et al. (1998) suggests that BEE policies have played important roles in reducing energy demand and improving energy use in building sector in the OECD (Organization for Economic Co-operation and Development) countries. And these policies typically include energy efficiency standards, voluntary agreements, financial incentives and market transformation programs. Iwaro and Mwashia (2010) presented the status of building energy regulations in 60 developing countries through an online survey, by analyzing present progress and barriers of the implementation of these regulations. Fayaz and Kari (2009) compared the introduction of various BEE codes developed in different countries and analyzed to what extent these codes have adapted international ISO 9164 codes with considering domestic characteristics in different countries. Casals (2006) presented an analysis on the roles, limitations and differences of various building energy-efficiency certifications with referring to the European context.

Whilst various BEE policies have been extensively introduced globally, the practices of these policies have encountered with various challenges in different countries. The study by Balachandra et al. (2010) suggests that the majority of developing countries have not implemented effectively their BEE policies largely because the economic development in these countries is the top priority in the governmental policy agenda. Ryghaug and Sørensen (2009) argued that energy-efficient building activities have been challenged by

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