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Energy Efficiency and Environmental Assessment for Buildings in Hong Kong

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ABSTRACT

Energy efficiency in buildings is critical to achieving sustainable development in a society. This paper presents an overview of the key issues and developments of energy efficiency and environmental assessment for buildings in Hong Kong. The current situation of building energy consumption and related energy efficiency programmes are explained. The development of building energy codes and environmental assessment methods for buildings are described and discussed. As many cities in the tropical and subtropical regions of Asia are facing a similar challenge on energy and environment, it is hoped that the experience in Hong Kong would provide useful information for understanding the common issues and designing effective strategy to promote energy conservation and environmental management in the building sector.

KEYWORDS: Building energy efficiency, building energy codes, environmental assessment, sustainability.

1. INTRODUCTION

Hong Kong is a fast developing, dynamic city with extremely high building density (Hui, 2001). As the population and urban development continues to intensify in the society, there is an increasing concern about the sustainability of the city (Barron and Steinbrecher, 1999). Since energy is the key ingredient to any economic activity and buildings are significant users of energy and materials, energy efficiency in buildings plays an important role for achieving sustainable development (Hui, 2002c).

In the past decade, Hong Kong was developing building energy codes and implementing energy-efficiency and environmental programmes with the aim to promote energy conservation and better building design (Hui 1999; Lam and Hui 1996). The study of "greener" and more energy-efficient buildings was also triggered by the quest for better performance and quality in the construction industry. A challenging task of building designers and professionals today is to promote green and energy-efficient buildings in a cost effective and environmentally responsive way.

This paper presents an overview of the key issues and developments of energy efficiency and environmental assessment for buildings in Hong Kong. The current situation of building

energy consumption and related energy efficiency programmes are explained. The development of building energy codes and environmental assessment methods for buildings are described and discussed. As many cities in the tropical and subtropical regions of Asia are facing a similar challenge on energy and environment, it is hoped that the experience in Hong Kong would provide useful information for understanding the common issues and designing effective strategy to promote energy conservation and environmental management in the building sector.

2. BUILDING ENERGY CONSUMPTION

Since the oil crises in the 1970s, Hong Kong has begun to study the issue of energy conservation in buildings by developing some basic concepts and guidelines. In the late 1980s and 1990s, as Hong Kong was undergoing an economic transformation from a manufacturing to a services centre, energy use by the manufacturing sector was declining and building-related energy consumption in the residential and commercial sectors was increasing steadily. Figure 1 shows the sectoral breakdown of end-use energy in Hong Kong for 1984-2000 (EMSD, 2002).

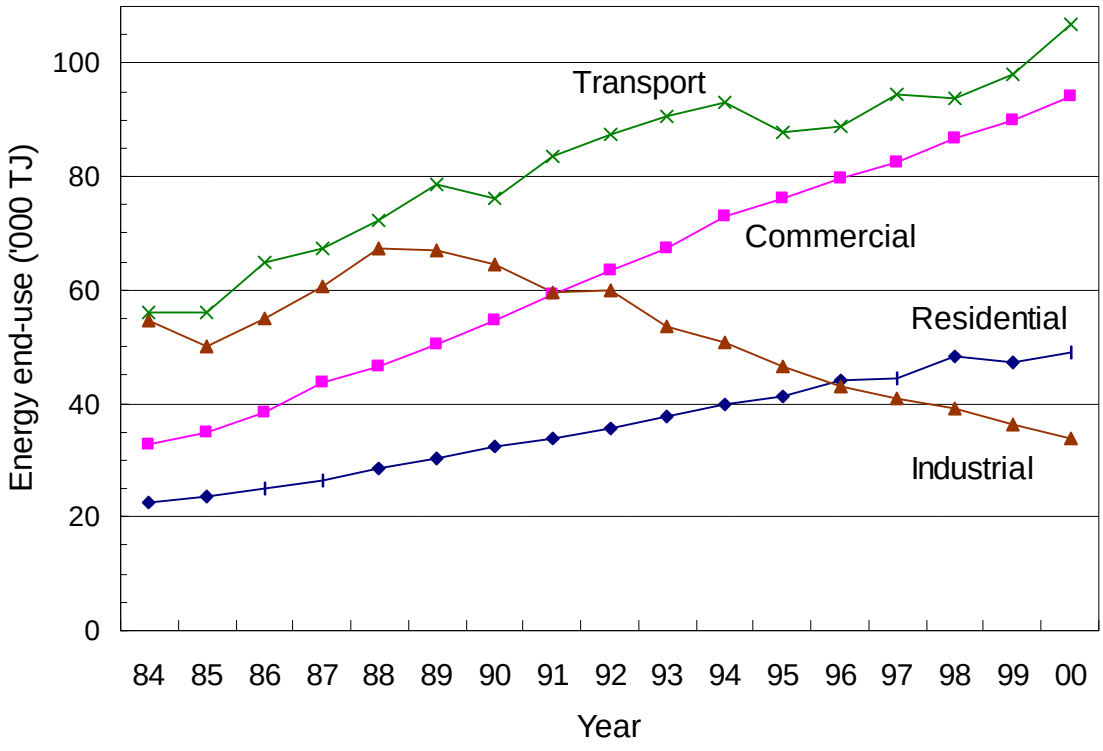

Figure 1. Sectoral breakdown of end-use energy in Hong Kong, 1984-2000

Nowadays, energy use in buildings represents a major portion of the community's energy demand, especially for electricity. In 2001, the building sector (commercial and residential) accounts for 85% of electricity consumption and over 38% of final energy requirements (CSD, 2002). Table 1 shows the final energy requirements in Hong Kong in 2001.

Table 1. Analysis of final energy requirements in Hong Kong, 2001

Unit: Terajoule	**Commercial**	**Residential**	**Industrial**	**TOTAL**
Electricity	84 580 (63%)	32 799 (24%)	16 759 (12%)	134 139 (100%)
Gas	11 060 (42%)	14 493 (54%)	1 011 (4%)	26 564 (100%)
Electricity + gas	95 640 (60%)	47 292 (29%)	17 770 (11%)	160 703 (100%)
Percentage *	25.5%	12.6%	4.7%	42.8%

Note: * Percentage of (electricity + gas) in the final energy requirements.

Electricity and town gas are the major forms of energy supply in buildings and their consumption in the commercial and residential sectors represents almost the total energy use of the building sector. It can be seen from Table 1 that commercial buildings constitute 25.5% of the final energy requirements and residential buildings account for 12.6%. As the energy use in commercial buildings is the most significant sector in Hong Kong and is growing faster than other sectors, many programmes or schemes on energy efficiency are targeting at the commercial sector, for example, the building energy codes.

3. BUILDING ENERGY CODES

Hong Kong Government has a fundamental economic policy of minimum interference in the business sector. That means market forces determine the allocation of resources and the Government intervenes only when there are over-riding social considerations. Over the past decades, this policy has shaped the development of Hong Kong's energy sector, in that it is the private sector that supplies energy of all forms to meet market requirements; regulation of the energy sector is relatively light-handed.

For energy efficiency in buildings in Hong Kong, the 1990s is a period of fundamental change in policy instruments and agency responsibilities. For instance, the Energy Efficiency Advisory Committee was set up in 1991 (it was later transformed into the Energy Advisory Committee in 1996) and the Energy Efficiency Office, the government's technical agency, was established in 1994. A number of tools and programmes have been implemented to encourage energy awareness (Hui, 1999).

Building (Energy Efficiency) Regulation (Hong Kong Government, 1995), which came into operation on 21 July 1995, is the first set of legislation in Hong Kong to control energy-efficient design in buildings. It specifies statutory control on the design of building envelope of new commercial and hotel buildings by using the overall thermal transfer value (OTTV) method (Building Authority, 1995). Lam and Hui (1996) have reviewed and analysed the method, which is also being used in Singapore, Malaysia, Philippines and Thailand. It was found that the OTTV method emphasizes the control of solar heat gain and is applicable, in principle, to warmer climatic regions of the world which have large energy requirements for air-conditioning. As compared with some comprehensive building energy standards which adopt a whole-building energy budget approach, the OTTV method is easier to understand and simpler to implement.

Apart from the building envelope standard, four sets of energy efficiency codes of practices for building services design have been prepared (EMSD, 1998a & b, 1999, 2000a). A new set of performance-based building energy code has recently been drafted (Hui, 2002a). Table 2 shows the current status of the building energy codes. These building energy codes were implemented initially on a voluntary basis, but they will be examined whether they should be put on a mandatory basis in the coming future.

Table 2. Building energy codes in Hong Kong

Code	Year implemented	Status	Scope
OTTV (building envelope)	1995	Mandatory	Commercial buildings and hotels
Lighting	1998	Voluntary	All buildings except domestic, industrial and medical ones
Air-conditioning	1998	Voluntary	All buildings except domestic, industrial and medical ones
Electrical services	1999	Voluntary	All buildings except special industrial process
Lifts and escalators	2000	Voluntary	All buildings except special industrial process
Performance-based building energy code	2003 (expected)	Voluntary (expected)	Commercial buildings and hotels

Note: Further information can be found at http://arch.hku.hk/research/BEER/.

4. RELATED ENERGY EFFICIENCY PROGRAMMES

To encourage wider acceptance of the voluntary building services energy codes, a scheme of accreditation for energy efficient buildings has been introduced in 1998. Under this scheme, any buildings (new and existing) that fully comply with the codes will be eligible for accreditation as an “energy efficient building”. A certificate of accreditation will be issued to the building’s owner and its name entered into a register kept by the Government. At the end of 2002, some 108 buildings have been included in the register.

For appliance energy efficiency, an energy-efficiency labelling scheme for electrical appliances has been implemented in Hong Kong since 1995 to provide consumers and decision makers with information on opportunities for energy efficiency. The aim of the scheme is to promote classes of products that save energy, create differentiation among products, and allow consumers to make an educated purchase. At present, some nine types of electrical appliances were put under this scheme including household refrigerators, room coolers (unitary air-conditioners), washing machines, compact fluorescent lamps, photocopiers, household electric storage water heaters, multifunction device (copying/printing/faxing), electric clothes dryers and electric rice-cooker.

In association with an initiative for demand-side management (DSM) for electricity, some programmes have been adopted to promote energy efficiency and reduce peak demand for electricity. Initiatives implemented both by the power companies and the Energy Efficiency

Office include advisory services on energy efficiency and conservation, education programmes for general public, energy-efficiency labelling scheme for appliances, incentive schemes for energy efficient lighting, air conditioning installations, and time-of-use tariffs for bulk commercial users.

To improve energy efficiency of existing buildings, energy audits have been conducted in government buildings since 1993 and measures have been implemented to achieve energy savings in these buildings. Information on retrofitting existing buildings with energy-efficient equipment is being disseminated to the private sector.

The Government is also exploring the potential for promoting water-cooled air-conditioning systems in large commercial buildings because it could produce electricity savings of 20-30% in air-conditioning plants (EMSD, 2000b). Pilot schemes for wider use of fresh water in evaporative cooling towers for energy-efficient air conditioning systems have been implemented in 2002 and 45 designated areas around the territories are included at this moment.

To provide useful information for policy planning and energy evaluation, an energy end-use database has been compiled since 1998 (EMSD, 2002). The database covers the consumption data of the different energy fuel types and the specific purposes for which these fuels are consumed, such as space-conditioning, lighting, cooking, etc. The data provides a better understanding of energy consumption patterns and usage, arousing public interest and concern over the future energy development in Hong Kong. To obtain information for continuous updating of the data, energy consumption surveys will be carried out regularly and follow-up technical studies are conducted to establish relevant energy consumption indicators and benchmark.

5. ENVIRONMENTAL ASSESSMENT METHODS

With more and more people concerning the environmental impacts of building and construction, some methods have been developed in the world for the evaluation of building environmental performance (Cole, 1999). The assessment of building environmental performance covers a wide range of issues and may involve a number of technological, ecological and socio-cultural factors (Hui, 2002c). Although there is still lack of agreement on the scope of assessment, the building's energy efficiency or performance usually forms a key element in the assessment process.

In the past few years, several methods have been developed and/or used in Hong Kong for assessing the environmental performance of buildings or building projects. Table 3 shows a summary of the assessment methods and their related websites on which further details can be downloaded. Although the general goal is similar, the specific approach and criteria taken by each method can be very different.

Table 3. Building environmental assessment methods used in Hong Kong

Assessment method	Year
Hong Kong Building Environmental Assessment Method (HK-BEAM) http://www.bse.polyu.edu.hk/Research_Centre/BEP/hkbeam/main.html • New offices (Version 1/96R) • Existing offices (Version 2/96R) • Residential (Version 3/99)	1999
Hotel Building Environmental Assessment Scheme (HBEAS) http://www.bse.polyu.edu.hk/Research_Centre/BEP/hbeas/main.html	2000
Green Building Tool (GBTool), 2000 & 2002 versions (used for assessment of building projects for Green Building Challenge) http://greenbuilding.ca/ or http://www.iisbe.org/	2000 & 2002
SPeAR (Sustainable Project Appraisal Routine) (used for assessment of some housing projects) http://www.arup.com/environmental/HTML/WhatWeDo/SPeAR.htm	2000
Intelligent Building Index (IBI), Version 2.0 (not designed specific for environmental assessment, but has some criteria related to environmental issues) http://www.aiib.net/	2001

The *Hong Kong Building Environmental Assessment Method* (HK-BEAM) was developed and implemented since 1996. It is derived from the Building Research Establishment Environmental Assessment Method (BREEAM) in UK and has been adapted with local settings (Baldwin, et al., 1998). Three versions of HK-BEAM were launched in the past few years, which covered new and existing office buildings and residential buildings (CET, 1999a, b & c). At present, some 70 buildings have been assessed. A derivative of HK-BEAM for existing hotel buildings, known as *Hotel Building Environmental Assessment Scheme* (HBEAS), was introduced in 2000 (HKHA, 2000). HK-BEAM is now being reviewed and updated. A new version is expected to come out later in the year 2003.

The *Green Building Tool* (GBTool) is the software implementation of the Green Building Challenge (GBC) which aims to develop a comprehensive, generic framework for sustainability assessment (Cole, 2001). Through international collaborative efforts, case study buildings from different countries have been evaluated and discussed. Hong Kong has participated the GBC in 2000 (Maastricht) and 2002 (Oslo). Therefore, a few building projects in Hong Kong have been selected and assessed using the GBTool.

The *Sustainable Project Appraisal Routine* (SPeAR) was developed by a private consulting firm in UK (Arup) and was adapted by its branch office in Hong Kong for the assessment of some housing projects. The projects were scored using a set of indicators, originally based on the criteria set out in UK and have been tailored to suit the task of appraising the sustainability of individual projects. Each indicator is scored on a scale ranging from ‘optimum case’ to ‘worst case’ scenarios.

The *Intelligent Building Index* (IBI) is not designed specific for environmental assessment, but it has some criteria related to environmental issues, for example the green index and cost effectiveness index (Wong, So and Leung, 2001). The scheme is still new and developing in

the market. Very few buildings have been assessed using this method at present.

6. DISCUSSIONS

Common strategies for energy regulation and policy include incentive schemes, voluntary standards, mandatory standards and energy labelling (Langston and Ding, 2001). Building energy codes are instruments that guide and specify the direction for improving energy efficiency practices. Legislations can take the form of regulations, guidelines, standards, codes, and others. They may call for voluntary or mandatory actions.

On the other hand, as building environmental assessment is still in the early stage of development and evolution in Hong Kong, not many building owners are interested in or have gone through the existing schemes. A systematic approach is needed to integrate the sustainability issues with market concerns that are also meaningful to the society. It is believed that the development of a set of comprehensive building energy codes will be useful and important for achieving this purpose.

Two important trends in Hong Kong on building energy code and environmental assessment scheme are highlighted below.

6.1 Performance-based building energy code

The existing building energy codes in Hong Kong, including OTTV, lighting, air conditioning, electrical, and lift & escalator, are based mainly on prescriptive requirements for individual building components (Hui, 2000). Although these requirements are simple to check, they do not consider holistically the whole building energy performance and this may become a major barrier to performance optimisation and design innovation. To provide greater design flexibility and encourage innovative energy-efficient techniques, a performance-based building energy code has recently been prepared in Hong Kong.

The performance-based concept emphasizes the practice of thinking and working in terms of ends rather than means (CIB, 1997). The performance-based building energy code will set a maximum allowable energy consumption level without specification of the methods, materials processes to be employed to achieve it. It can be used to allow trade-offs among different aspects of the assessment such that a combination of measures that would yield the best possible performance within the budget constraint can be adopted.

To implement the performance-based approach, the complexity of whole building compliance process should be resolved through careful code design and suitable capacity building activities. It is believed the new performance-based code will form a base for designing the energy criteria in various environmental assessment schemes.

6.2 Comprehensive environmental performance assessment scheme

Hong Kong Government is planning to set up a green building label system as a means of using market force to promote environmentally-friendly buildings. A 9-month consultancy study to develop the method, known as “Comprehensive Environmental Performance Assessment Scheme (CEPAS) for Buildings”, was commissioned in Autumn 2002. It is believed the experience of the existing assessment methods will form a useful background of

this study. At the same time, review of the building regulations is being conducted with the aim to remove barriers to innovative and green building designs. These initiatives focus not only on new buildings but also on redevelopment of old and dilapidated buildings in the urban renewal process.

An objective and sufficiently demanding measure will be needed to design the new environmental assessment scheme in Hong Kong and to develop relevant performance indicators and benchmarks for charting environmental and sustainability progress. Although it is too early to describe the assessment scheme, it is believed that the following criteria are important for such a scheme.

- Understandable and acceptable by building professionals and general public.
- Practical and cost effective to implement.
- Technically sound and well supported by local research and analyses.
- Clear objectives and good considerations of local conditions.
- Efficient mechanism for implementation, capacity building and market stimulation.

To ensure successful implementation of the scheme, guidelines for green building design will be developed to provide practical assistance to building designers and encourage wider acceptance of the assessment method.

5. CONCLUSION

Sustainability is no longer a luxury to be considered when economic times are good. It is an imperative to be actively pursued with a sense of urgency. During the period of economy downturn (currently in Hong Kong), people will often appreciate more the energy conservation opportunities in their premises. There is a good potential for promoting energy efficiency and sustainability in building in this period in order to achieve holistic and effective building design, operation and management.

Like many other urban cities, the commercial and residential buildings in Hong Kong play a significant role in determining sustainable development of the society. Proper coordination of the building energy codes and the environmental assessment schemes is needed. At present, many of the existing building energy codes in the world are prescriptive in nature. To provide greater design flexibility and encourage innovative design, it is important to move towards performance-based approach and consider the integrated whole building performance in the design and evaluation. To obtain these advantages in the environmental sustainability assessment of buildings, further efforts are needed to integrate the requirements of building energy codes and the performance concept into the sustainability assessment process. This will help to strengthen the technical base of and confidence with the assessment method.

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