EEO/Q284
Study on Enhanced Promotion of Building Energy Codes in Hong Kong

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Development Report

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Prepared for

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LIST OF ABBREVIATIONS AND ACRONYMS

ABCB	Australian Building Codes Board
ABEC	Australian Building Energy Council
AC	Air-conditioning
ACT	Australian Capital Territory
ACTHERS	ACT House Energy Rating Scheme, Australia
AGO	Australian Greenhouse Office
ANSI	American National Standards Institute
AP	Authorised Person
ASEAN	Association of Southeast Asian Nations
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
B&CA	Building and Construction Authority, Singapore
BCA	Building Code of Australia
BCD	Building Control Division, Singapore
BD	Buildings Department, Hong Kong
BEC	Building energy code
BERC	Bureau of Energy Regulation and Conservation, Thailand
BEST	Building energy standard software, Singapore
BOCAI	Building Officials and Code Administrators International
CBEEA	China Building Energy Efficiency Association
CDM	Clean Development Mechanism
CEC	California Energy Commission
CEMEP	European Committee of Manufacturers of Electrical Machines and Power Electronics
CEN	European Standards Organisation
CIBSE	Chartered Institution of Building Services Engineers
COMcheck	Commercial code checking software, USA
CSD	Census and Statistics Department, Hong Kong
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DANCED	Danish Co-operation for Environment and Development
DBCD	Development & Building Control Division, Singapore
DCER	Design Carbon Emission Rate
DEDP	Department of Energy Development and Promotion
DETR	Department of the Environment, Transport and the Regions, UK
DTLR	Department for Transport, Local Government and the Regions, UK
EEO	Energy Efficiency Office
EMSD	Electrical and Mechanical Services Department
ENVSTD	Envelope standard software, ASHRAE
EPAct	Energy Policy Act
EPBD	Energy Performance of Buildings Directive
ESCO	Energy services companies
ETTV	Envelope thermal transfer value
ETWB	Environment, Transport and Works Bureau, Hong Kong
EU	European Union
EuroACE	European Alliance of Companies for Energy Efficiency in Buildings
GB	Great Britian or Gou Bei (Chinese National Standard)
GJ	Gigajoule
HD	Housing Department, Hong Kong
HDB	Housing Development Board, Singapore
HK	Hong Kong
HKEERSB	Hong Kong Energy Efficiency Registration Scheme for Buildings
HVAC	Heating, ventilating and air-conditioning
IA	Impact assessment
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
IECC	International Energy Conservation Code
IESNA	Illuminating Engineering Society of North America
kWh	Kilowatt hour
LTGSTD	Lighting standard software, ASHRAE
MJ	Megajoule

MOC	Ministry of Construction, People's Republic of China
NatHERS	Nationwide House Energy Rating Software, Australia
NDRC	National Development and Reform Commission, People's Republic of China
NEA	National Environmental Administration, Singapore
NEEC	National Energy Efficiency Committee, Singapore
NEPO	National Energy Policy Office, Thailand
NUS	National University of Singapore
OTTV	Overall thermal transfer value
PB-BEC	Performance-Based Building Energy Codes
PPS	Planning Policy Statements
PSB	Productivity and Standards Board, Singapore
R-value	Effective thermal resistance (unit: m^2 .K/W)
RE	Renewable energy
REScheck	Residential code checking software, USA
RIA	Regulatory impact assessment
RTTV	Roof thermal transfer value
RVD	Rating and Valuation Department, Hong Kong
SAP	Standard Assessment Procedure
SS	Singapore Standard
SISIR	Singapore Institute of Standards and Industrial Research (now Singapore's Productivity and Standards Board)
SWH	Service water heating
TCER	Target Carbon Emission Rate
U-value	Overall thermal transmittance (unit: $W/m^2.K$)
UK	United Kingdom
USA	United States of America
USDOE	US Department of Energy
WSD	Water Supplies Department, Hong Kong

1. INTRODUCTION

This report explains the major outcomes at the Development Stage of the "Study on Enhanced Promotion of Building Energy Codes in Hong Kong (EEO/Q284)", commissioned by the Electrical and Mechanical Services Department (EMSD). This study is very important to our society because buildings are major consumers of energy and they will affect the economic and environmental sustainability of the community. The existing policy and building energy codes (BECs) in Hong Kong have been in place for almost 10 years. There is an urgent need to review and enhance their acceptance and effectiveness.

1.1 Background of the Study

This study asks for viable approaches on BEC promotion and implementation for new and existing buildings. The aim is to enhance the BEC application and achieve notable improvement on building energy efficiency and conservation in Hong Kong. By studying the worldwide experience and local context, it is possible to identify key issues and recommend effective strategies for enhancing the implementation of BECs.

1.1.1 Scope of Work

The study brief has suggested four stages for this project as shown below and the specific tasks are indicated. At the Development Stage, the main purpose is to compare the BEC characteristics, evaluate the strategies for implementation and promotion, and assess the policy design and approaches for developing the recommendations.

- Inception Stage
- Research Stage
- Development Stage
- Reporting Stage

It is also required to recommend the scope and content of regulatory impact assessment that may be conducted in the future, in case mandatory implementation is adopted as one of the recommended approaches.

1.1.2 Reports of Previous Stages

The following two reports have been prepared in the previous stages of the study to explain the research methodology and findings. This Development Report follows the line of thought and evaluates critically the strategies for future BEC development.

- Inception Stage – An Inception Report submitted in March 2007
- Research Stage – A Research Report submitted in July 2007

During the investigation, the worldwide experience in "**6 + 1**" focal points (including Australia, China, Singapore, Thailand, UK and USA, plus European Union's Directive on Energy Performance of Buildings) have been analysed. Local review and assessment have been done to evaluate the performance of the voluntary Hong Kong Energy Efficiency Registration Scheme for Buildings (HKEERSB) and assess the critical factors for policy planning and design.

1.2 Basis of the Analyses

The basic research approach of this study includes scientific and academic investigations of the major BEC issues and policy implications through the following methodology:

- Literature search and study
- International review and comments
- Local review and assessment
- Critical evaluation and strategy development

The research findings from this study will provide useful information to policy makers and other related bodies for enhancing the policy design and implementation strategy. The results of the study will also form the basis for preparing impact assessments in the coming future.

It should be noted that the BECs in Hong Kong have been revised and updated in the past few years. The latest version (2007) was released in March 2007, during the early stage of the present study. This 2007 version of the BECs as well as the previous versions have been considered in the present investigation. But for the analysis of the past experience with the BECs, only the previous versions will affect the results because the 2007 version will only come into effect in October 2007.

1.3 Report Organisation and Approach

The report is divided into five chapters. Chapter 1 is the introduction. Chapter 2 describes the characteristics of building energy codes in Hong Kong and other places. Chapter 3 explains the implementation and promotion strategies being developed and proposed. Chapter 4 explains the policy design and planning issues and describes the necessity of an impact assessment. Chapter 5 is the conclusion.

2. PROMULGATION OF BUILDING ENERGY CODES

BECs are instruments that guide and specify the direction for improving energy efficiency practices (ABCB, 1999). They have been adopted in many countries worldwide to provide a degree of control over building design practices and to encourage awareness and innovation of energy conscious design in buildings. Promulgation of BEC can take the form of regulations, guidelines, standards, codes etc. The status of the BECs in Hong Kong and other countries are described in this Chapter, with the aim to enhance better understanding of the development of BEC in the respective regions.

2.1 Hong Kong Situation

With a growing concern about energy consumption and its implications to the environment, actions were taken by the Government in 1990s to promote energy conservation and a set of BECs was developed to control the total energy consumption in new commercial and office buildings.

2.1.1 Current BECs

The building energy codes apply to building envelope, lighting systems, air-conditioning systems, electrical systems and lifts and escalators, which are the major energy consuming elements in commercial and office buildings. A performance-based BEC was also established to allow a certain trade-offs among the systems and provide an alternative path for compliance for some innovative building projects. To provide assistance for application of the codes and other energy saving measures, some guidelines documents have been prepared and published as well.

At present, the building envelope (OTTV = overall thermal transfer value) code is linked with the Building (Energy Efficiency) Regulation under the Building Ordinance, forming a mandatory requirement for new commercial and hotel buildings. The other five energy codes are implemented on a voluntary basis under the Hong Kong Energy Efficiency Registration Scheme for Buildings (HKEERSB) managed by EMSD. Nonetheless, in December 2005, the HKSAR Government issued the ETWB TC (W) No. 16/2005 to require all new government projects and major retrofit work , among other things, to adopt the BECs as the baseline for building design. For the private sector, the participation in the HKEERSB is rather low.

Table 2.1 shows the current codes of practices in Hong Kong which cover various aspects of building energy efficiency.

Table 2.1 Building energy codes in Hong Kong

Area of concern	First issued	Current version	Status	Scope of application
Building envelope (OTTV)	1995	2000	Mandatory (by BD)	Commercial buildings and hotels
Lighting	1998	2007	Voluntary (by EMSD)	All buildings except domestic, industrial and medical ones *
Air-conditioning	1998	2007	Voluntary (by EMSD)	All buildings except domestic, industrial and medical ones *
Electrical	1999	2007	Voluntary (by EMSD)	All buildings except for special industrial process *
Lift and escalator	2000	2007	Voluntary (by EMSD)	All buildings except for special industrial process *
Performance-based	2004	2007	Voluntary (by EMSD)	All buildings except for special industrial process

Note: * Communal areas of domestic and industrial buildings are included under the present scope.

2.1.2 BEC Approaches

At present, the HKEERSB has included three general approaches for demonstrating compliance, namely, prescriptive, performance-based and benchmark data. It is believed that different building projects and situations will require different approaches to apply BEC. For small and simple buildings, if the building owners or developers do not prefer significant efforts for the code compliance, then the prescriptive codes will give them a straightforward compliance path. If the building project is large or if it involves some innovative building design that the prescriptive codes cannot address, then the

Performance-based Code will provide an effective tool for compliance as well as investigation of energy-efficient building design features.

The approach of benchmark data (i.e. Good Energy Performance Certification) was introduced only recently in 2007. It is applied mainly to existing buildings which have real-life energy consumption data available for comparison with the “Energy Consumption Indicators and Benchmarks” developed by the EMSD (http://www.emsd.gov.hk/emsd/eng/pee/ecib.shtml). Through activities such as energy audit and energy management programmes, it is possible to enhance energy awareness in existing buildings and promote energy saving measures to building owners.

Table 2.2 summarises the approaches and provides their key features.

Table 2.2 Approaches of the BECs

Approach	Related code or method	Key Features
Prescriptive	Lighting Code, AC Code, Electrical Code, Lift & Escalator Code	- Simple and easy to enforce - Restrict innovation - No trade-offs allowed
Performance-based (total building energy consumption)	Performance-based Code	- Complicated and requires skills - Can encourage innovation - Flexible and allow trade-offs
Benchmark data (Good Energy Performance Certification for existing buildings)	Energy audit and benchmarking the energy performance with existing buildings	- Simple and direct assessment - Apply only to existing buildings - Can only cover building types with benchmark data

2.2 Worldwide Experience

At present, most countries in the world have building energy codes in place at the national, regional, and/or local levels for regulating health and safety concerns in buildings (UN-ESCAP, 1999). Energy efficiency is often added as a component to the building codes and carried out through similar control processes.

A total of 6 economies have been studied in the worldwide review and they include Australia, China, Singapore, Thailand, UK and USA. In addition, the “EU Directive on the Energy Performance of Buildings” (EU, 2002) was evaluated to provide insights into future developments of BEC in Europe.

Table 2.3 shows a summary of the worldwide BEC experience for the six candidates being reviewed. All the BECs in these countries contain prescriptive provisions and some of them have performance requirements which are supported by trade-off approach and energy rating approach.

Table 2.3 Summary of worldwide BEC experience

	Australia	China	Singapore	Thailand	USA	UK
Links with Building Regulations	Yes	Yes (varied)	Yes	No	Yes (varied)	Yes
Energy certificates or labels	No	No	No	No	Yes	Yes (dwellings)
Other related programmes	Yes	Yes	Yes	Yes	Yes	Yes
Compliance software tools	Yes	No	Yes	Yes	Yes	Yes
Performance-based approach	Yes	No	Yes	No	Yes	Yes
Penalties for non-compliance	Yes	Yes	Yes	Yes	Yes	Yes
Incentive scheme for energy efficiency	Yes	No	Yes	Yes	Yes (varied)	Yes

Note: Detail of the worldwide BEC is given in the Research Report

2.2.1 BECs in Australia and China

Australia

The *Building Code of Australia* (BCA), produced and maintained by the Australian Building Codes Board (ABCB), has been given the status of building regulations by all States and Territories. The BCA was amended in 1996, and BCA 96 was adopted nationally in July 1997. BCA 96 was again updated, most recently in 2006, and has now been amended to include energy efficiency measures for all building classifications covering apartment unit, hotel, office, shop, health care, school etc. The BCA focuses on new buildings and major retrofits. The energy efficiency requirements embrace the building envelope including insulation and various building services of lighting, air conditioning, service water heating, metering, energy audit, operation & maintenance and building energy performance etc.

The BCA requirements are promulgated in each State under its own Act and regulations. The actual requirements in the Act and regulations among States usually differ. Nevertheless, the compliance control mechanism of submission to authority and withholding of occupation permit against non-compliance is quite similar, as both the energy efficiency requirements and the building safety requirements come under the same set of BCA. Referencing to the BCA, States also require buildings to attain a certain level of energy labeling, such as the ACT House Energy Rating Scheme (ACTHERS) of four stars in the Australian Capital Territory, the Nationwide House Energy Rating (NatHERS) of 3 or 4 stars in South Australia, the Victorian House Energy Rating Scheme of 3 stars in Victoria etc. Software programs & systems have been developed for the benchmarking of buildings.

Mainland China

In Mainland China, the energy legal system includes national energy laws, provincial codes, departmental regulations, rules and orders. Many of the energy laws and regulations are administrative rules and orders issued by the state Council, and some of them are commands, directions and orders issued by the departments and committees under the State Council. Generally, China has developed a BEC system including design standards, testing standards, management standards, and building energy consumption standards. Enforcement of the BEC are vested with the authorities at district or city level. The major BECs set up have been indicated in the Research Report. At the provincial level, some provinces and cities, like Shanghai, Jiangsu,Chongqin and Anhui have proposed or already set up their local BEC to cater for the individual characteristics of their cities, such as the tall height in Shanghai and extreme hot & cold climates in Chongqing.

With increasing concern on energy conservation in the Mainland, a Building Energy Conservation & Management Regulation has been drafted and is under consultation, which will bring enhanced control on building energy efficiency. For similar purpose, the National Development & Reform Commission (NDRC) has issued a notice "On Strengthening Energy Conservation Evaluation & Review of Fixed Asset Investment Projects", which requires that after 1 January 2007 all fixed asset investment projects of more than RMB500,000 shall file a feasibility study or project application report, which shall include energy conservation analysis, with the NDRC for approval. The notice states that the energy conservation analysis shall be prepared on principles following national standards for rational energy consumption and codes for energy conservation design, BECs naturally included. The NDRC has also issued guidelines to the notice, which serve to integrate the existing applicable laws and regulations, industrial & technological policies, standards and design codes to provide a basis for the energy-saving evaluation & review of fixed asset investment projects, which specifically address several sectors including the building sector. The guidelines has also addressed the Standard for Evaluation of Green Buildings, GB/T503782006, a standard on green labelling of building.

The notice draws attention on monitoring of project construction such that if a construction-phase inspection reveals noncompliance, an order shall be issued to urge stopping construction, and making corrections within a prescribed time, and relevant entities shall be held liable accordingly.

2.2.2 BECs in South East Asia and USA

The BEC experience of the South East Asian countries is of particular interest to Hong Kong because they have similar climate and social structure to us. Like Hong Kong, these countries have rapid economic growth and extensive building and infrastructure developments in the past decades. The

Southeast Asian countries include Singapore, Malaysia, Philippines, Thailand and Indonesia. These countries are members of the Association of Southeast Asian Nations (ASEAN). Figure 2.1 shows the development of BECs in USA and Southeast Asian countries.

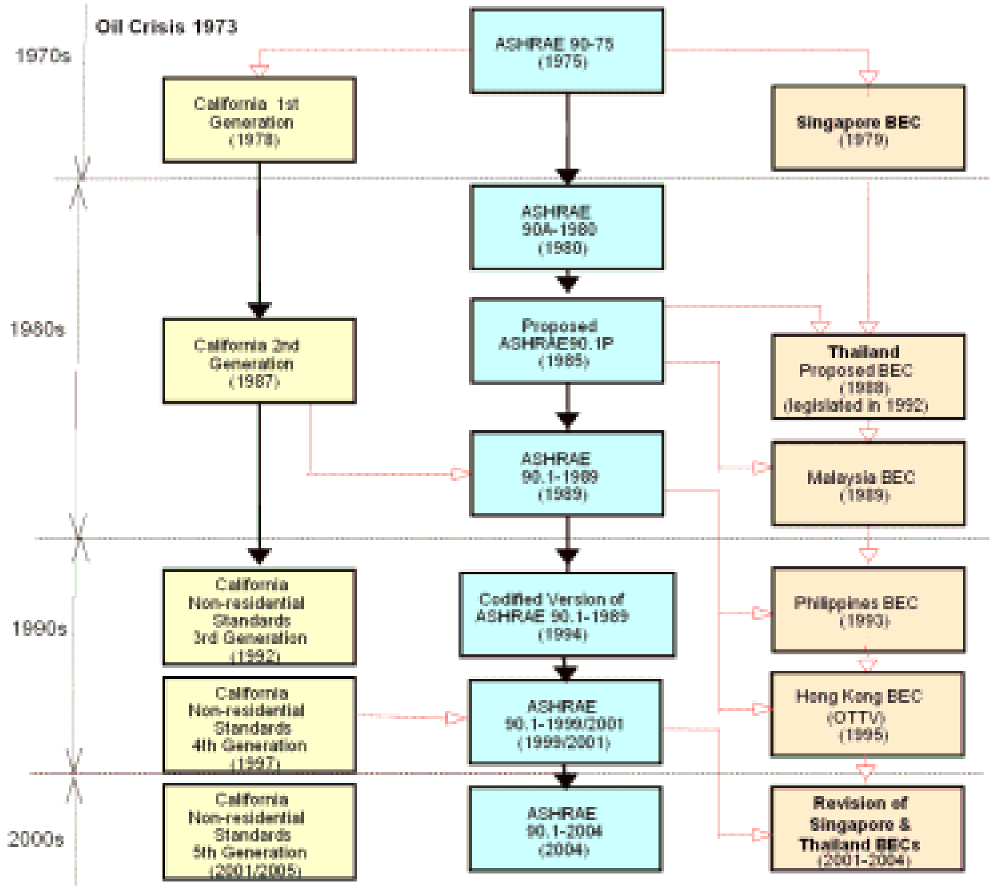

Figure 2.1 Development of BECs in USA and Southeast Asian countries

In the past decades, the ASEAN countries, have investigated their own BEC and implemented many programmes for building energy conservation. The design of their BECs was influenced by the ASHRAE Standard 90 series and the California Title 24. The overall thermal transfer value (OTTV) method is used in the ASEAN countries (and also in Hong Kong) as a control measure for building envelope design. Originated from ASHRAE, OTTV is an index for comparing the thermal performance of buildings. It is a measure of the average heat gain into a building through the building envelope and consists of three major components: (a) conduction through opaque walls, (b) conduction through window glass, and (c) solar radiation through window glass.

The control on OTTV aims at reducing external heat gains through the building envelope and hence the electricity required for air-conditioning. Usually, the solar component is the most significant element in the OTTV calculation. The biggest limitation of the OTTV method is that it only deals with the building envelope and does not consider other aspects of building design (such as lighting and air-conditioning) and the coordination of building systems to optimize the combined performance. To resolve this limitation, some countries have enhanced their BECs by developing energy efficiency requirements on building services and equipment. Many countries are also moving towards energy performance criteria or codes which give designers greater flexibility.

2.2.3 Singapore Approach

The BEC development in Singapore is a useful reference for Hong Kong. In Singapore, the specific energy efficiency requirements were contained in the Building Control Act and Building Control Regulations. At present, under an Approved Document (B&CA, 2007), the regulations reference the ETTV (envelope thermal transfer value) Guidelines and Singapore Standards (SS530, CP13 & CP38 on building services installations) as acceptable solution. The penalty for non-compliance is significant (a fine of up to Singaporean $5,000 or imprisonment of up to six months or both) and the regulations are applied to all new offices, commercial, industrial and institution buildings. For existing buildings, tax reductions and other financial incentives are available to encourage building owners to retrofit their buildings to comply with the BEC (Details indicated in Research Report).

Figure 2.2 shows the current regulatory framework for building energy efficiency in Singapore and Hong Kong. Their basic approach is similar to each other but Singapore has updated the regulations more often than Hong Kong and has national technical standards prepared for the purpose.

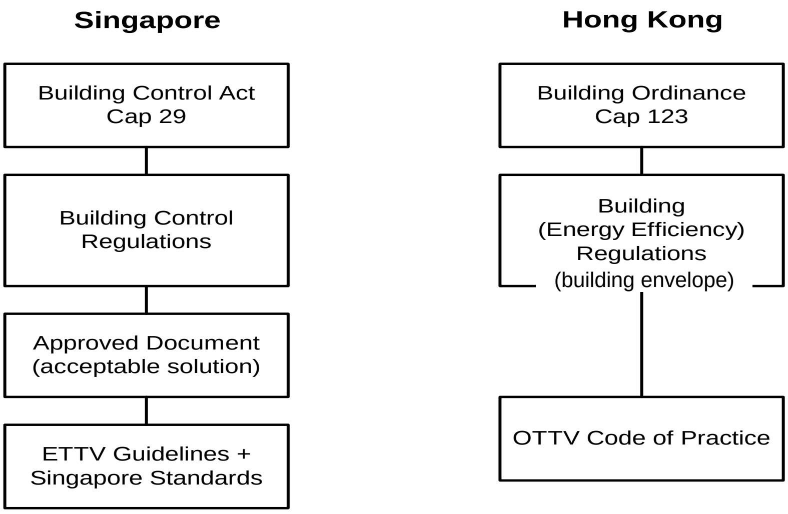

Figure 2.2 Regulatory framework for building energy efficiency in Singapore and Hong Kong

The Singapore Standards are national standards that are developed by the industry for the industry's use.

2.2.4 EU Directive

The energy efficiency activities in Europe are closely linked with environmental policy, particularly climate change. The EU has issued "The European Union (EU) Energy Performance of Buildings Directive (EPBD)" (EU, 2002), with principal objectives:

- To promote the improvement of the energy performance of buildings within the EU through cost effective measures, and
- To promote the convergence of building standards towards those of member states which already have ambitious levels

The EPBD is an important energy policy in Europe, which came into force on 4 January 2003. Under this Directive, each EU country is required to ensure suitable legislation be in place to promote energy efficiency in buildings. This policy will greatly affect awareness of energy performance of buildings and hopefully will contribute to reducing carbon dioxide emissions under the Kyoto protocol (Europe overall -8% emission by 2008-12 compared with 1990 level). At present, many European countries are moving to adopt and implement the EPBD. This will mean significant change that could affect their energy efficiency strategies and provisions. This may, in turn, prompt other countries to review their BEC requirements and implementation methods.

Each EU member state is required to transpose the Directive into law by the beginning of 2006 with a further three years being allowed for full implementation of specific articles. This will allow EU member states to develop suitable energy rating systems and certification schemes for all buildings that fall within the scope of the Directive, as well as taking into account the amount of time needed for the accreditation and training of sufficient personnel to undertake the energy performance assessments.

The EPBD will greatly affect awareness of energy use in buildings, and is intended to lead to substantial increases in investments in energy efficiency measures within these buildings (CIBSE, 2003). The benefit of the EPBD is that it provides an integrated approach to different aspects of buildings energy use.

Besides the EPBD, EU has also published in 2006 a new directive on energy end-use efficiency and energy services (EU, 2006), with the aim to create stronger incentives for the demand side and in the public sector. Like all EU Directives, it has to be implemented in full into the laws of all 25 EU Member

States. This Directive has six key elements:

- The preparation of national energy efficiency action plans every 3 years
- National indicative energy savings targets of 9% in 9 years
- The important role of the public sector, particularly as a market driver
- Governments can impose public service obligations regarding energy efficiency on those operating in the gas and electricity sectors
- Creating conditions to develop and promote a market for energy services (ESCOs)
- Requirements on metering and billing

It can be seen that this Directive will enable the market of energy services companies (ESCO) and energy performance contracting to develop. They are especially important for existing buildings that need to raise money for investments in energy efficiency based on future savings. Energy performance contracting is a financing technique that raises money for investments in energy efficiency that is based on future savings.

It is believed that the two EU Directives will have a significant impact on the design, use and marketability of buildings in respect of their energy-efficiency.

2.3 Latest Trends and Developments

In Europe and USA, energy label and rating systems for buildings as a form of BEC compliance are developing very fast. They can give a simple indication of the building energy performance and facilitate a market force within the consumers and end-users for enhancing energy awareness and making informed decisions. Some of them also help to qualify buyers for certain mortgage financing or utility rebate programs that reward energy-efficiency. Figure 2.3 shows an example of building energy rating now being developed in Ireland.

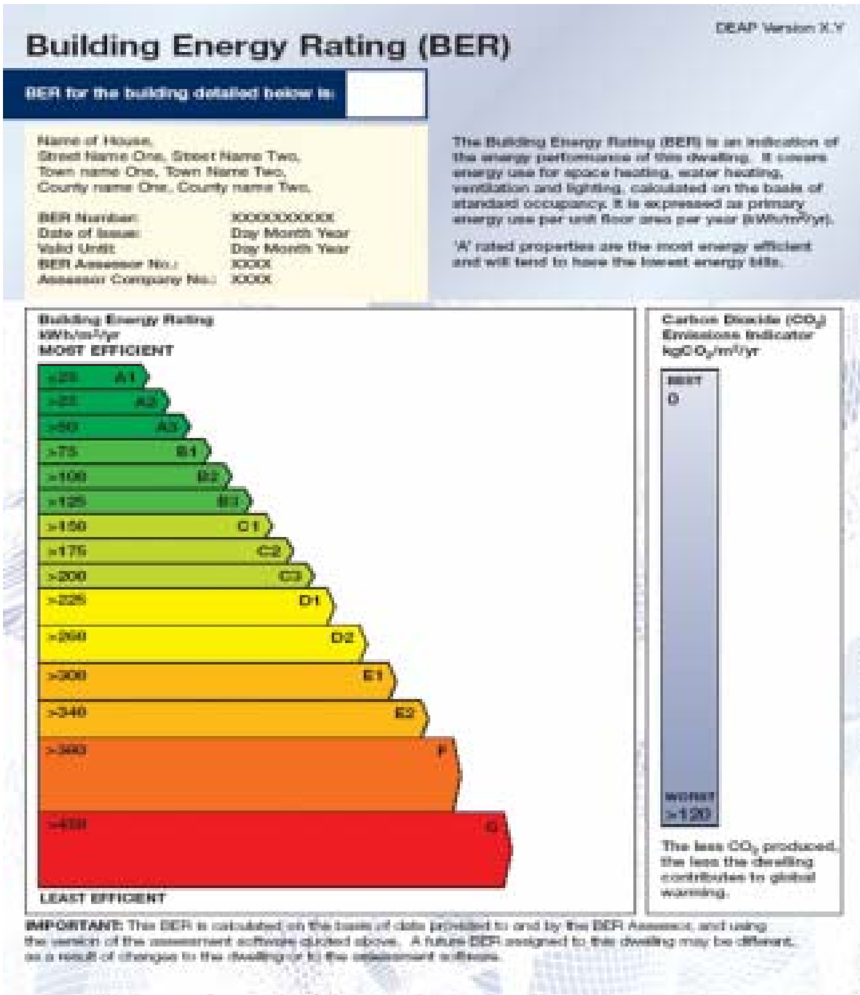

Figure 2.3 Example of building energy rating (source: Sustainable Energy Ireland, www.sei.ie)

The energy labels or certificates form important energy identification documents for both existing and new buildings. They can be established when some local standards or BECs are available for assessing and benchmarking the building performance.

Under the EPBD, building developers and landlords must provide a recent energy performance certificate (issued by the relevant authority) to give prospective owners or tenants better information on the expected running costs of a building or apartment. The certificates should also include recommendations for improving energy performance. Whenever a building is constructed, sold or rented out, a certificate detailing its energy performance must be made available. With buyers and prospective tenants better informed, it is believed that builders and landlords will have greater incentive to incorporate energy-efficient technologies and designs into their buildings, in return for lower running costs.

At present, some EU countries such as Austria, France and Germany have already implemented and mandated the energy performance certificate (also called "energy passport" system). These certificates are displayed in large buildings (over 1,000 m^2) regularly visited by the public, to raise awareness among citizens of the issue of energy efficiency in their local community. Recommended and current indoor temperatures may also be displayed.

2.4 What Can Be Learned

It should be noted that not all the overseas BEC requirements and criteria can be applied to Hong Kong directly. Some of the performance criteria are tailor-made to commensurate with experience in their climate and other requirements of social and cultural background. We need to be aware of our own situation when considering and determining what can be learned.

Nevertheless, some BEC promotion strategies and experience in other countries are useful to Hong Kong. Their ideas are described in this Section.

2.4.1 EU's Strategy for Promoting Building Energy Efficiency

The EU has provided a strong policy, legislative and financial support framework that can have a significant impact on the buildings sector (Janssen, 2005). Through implementation of the EU Directives, national energy policies and energy efficiency programmes, the EU has adopted a proactive role for driving energy efficiency in Europe and the world.

The strategy for promoting building energy efficiency in Europe could be seen as a "push and pull" approach, that is, market forces + legislation (see Figure 2.4). The EPBD is designed to remove barriers to allow market forces to allocate economic and natural resources effectively. To achieve the best outcome, the BECs play an important role to facilitate the market transformation.

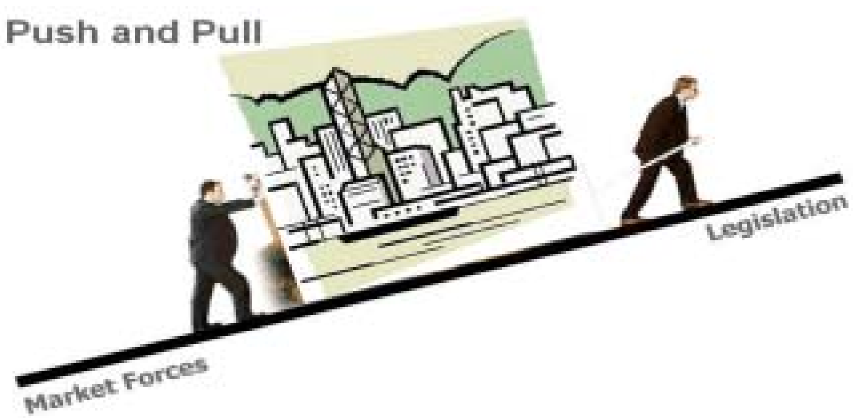

Figure 2.4 Strategy for promoting building energy efficiency (adapted from www.euroace.org)

For the push (using market forces), the EPBD can ensure ease of comparison for building energy performance and this allows construction industry to use the information as a marketing tool. Increased information to purchasers and tenants may be used in decision whether to take possession of the property or not. Also, the energy certification scheme may lead to public "naming and shaming" of public buildings that have high energy efficiency.

For the pull (legislative requirements), the EPBD sets out the legislative framework for controlling minimum energy performance in different European countries. Builders are made to buy and use energy efficient products in all new buildings and major renovation works. Hopefully, purchasers and tenants will demand higher standards of energy efficiency in buildings.

2.4.2 Reverse the Vicious Circle of Energy Efficient Buildings

At present, the promotion of energy efficient buildings is often hindered by some institutional barriers and the lack of understanding and support from the major stakeholders. It is a fact that the issue of energy is "invisible" to most people in the commercial building investment business and that low energy buildings are not valued more than standard buildings. Figure 2.5 shows a typical vicious circle of energy efficient buildings and this explains why the stakeholders are often hesitated to demand or design energy efficient buildings.

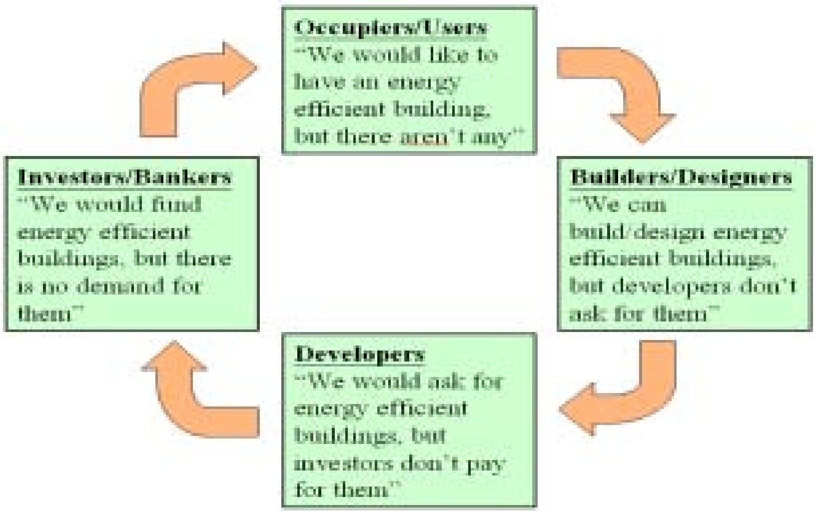

Figure 2.5 The vicious circle of energy efficient buildings

In order to overcome the barriers, catalysts such as the EPBD and the BECs are often required. Figure 2.6 show a way to reverse the vicious circle and overcome the market barriers. The vicious circle can turn into a virtuous circle when the stakeholders are well informed and the value of energy efficiency is fully appreciated. To achieve this, it is important to establish a link between energy efficiency and marketability. If energy-efficient buildings are seen by developers, investors and owners as having greater inherent value than inefficient buildings, it will greatly increase the likelihood of existing buildings being improved and of new buildings being constructed to increased standards of energy efficiency.

Figure 2.6 Reverse the viscous circle and overcome market barriers

3. IMPLEMENTATION AND PROMOTION STRATEGIES

Promotion of energy efficiency is often identified with government initiatives. Most of these efforts are designed to remedy market failures through initiatives to overcome market barriers and by setting a framework that translates the policies and strategies into action. To be effective, strategies must build on these efforts and support all market players.

Implementation and promotion strategies is a critical factor determining the effectiveness of the BEC. At present, much of the effort and published work on BEC has focused on issues related to their design and development. Yet the implementation issues that take place subsequent to their development have not been considered and investigated sufficiently (Busch and Deringer, 1998).

Implementation encompasses both startup activities to launch the code and ongoing activities to maintain an operation and improve it over time. These activities can include training; marketing, promotion, and advertising; staffing and institution building; field testing, enabling compliance; evaluation; revision and updates; or so on.

3.1 Private Sector

For the private sector, without the backing of energy conservation legislation, it is not easy to increase BEC adoption. Only when improved energy efficiency became a priority did it become obvious that the market was not functioning in a manner that encouraged improved energy efficiency.

If the private companies consider good company image and reduced operating costs as important factors, then suitable strategy could be made to enhance the publicity matters (such as promote the good performance buildings and list out those poor players) and introduce incentive systems (such as accelerated depreciation). It is believed that an appropriate strategy for the private sector involves both the encouragement of voluntary measures by industry and the introduction of mandatory minimum requirements in the Building Regulations.

3.1.1 New and Existing Buildings

Most of the BEC in the world are designed for new buildings and some also cover additions or alternations to existing buildings, including major renovations. Judging from the worldwide experience and current Hong Kong practice, it is believed that the mandatory BECs should be applied to new buildings in the beginning because the existing buildings cannot be modified quickly to meet the modern energy efficiency requirements.

New technologies are easy to incorporate into new buildings that impact the efficiency of the new construction market, while the existing building stock has a higher barrier to improvement. Existing stock could improve over time due to two factors: first, appliances are replaced with substantially more efficient ones due to the influence of the appliance efficiency standards. Second, alterations are made that evoke the BEC. Over time, the average efficiency of existing stock increases slightly because newer, more efficient stock is folded into the total stock each year, increasing the proportion of efficient buildings vs. inefficient ones. Other factors such as improved operation, commissioning, and ongoing maintenance can also improve performance of existing stock.

In order to promote and capture energy savings in existing buildings, it is important to raise the energy awareness among the building owners and users. As the building stock in Hong Kong increases steadily in the past few decades, there is a significant number of existing buildings at the age of 20 years or above. The maintenance of existing buildings in Hong Kong becomes a very important issue for promoting energy efficiency. Overseas, there are incentive programmes for existing buildings under demand side management or with government subsidy/loan on improvement of building energy efficiency. In Hong Kong, improvement to energy performance in existing buildings can be referenced to BEC compliance and through an approach acceptable by the various stakeholders, which is to be further explored, consulted and determined. Table 3.1 shows examples of the energy efficiency strategies for new and existing buildings. BECs are considered very important for new buildings, whereas energy audit and energy management programmes relevant to existing installations are very important to existing buildings. With BECs being a very good reference when improving existing installations, BECs are considered important for existing buildings.

Table 3.1 Energy efficiency strategies for new and existing buildings

Energy efficiency strategies	New buildings	Existing buildings
Building energy codes	Very important	Important
Energy audit	Not applicable	Very important
Energy management programme	Not applicable	Very important
Financial incentives	Important	Important
Penalties	Important	Important
Promotion campaign	Important	Important
Education and information	Important	Important
Building energy labels	Important	Important
Research & development	Important	Important

An effective energy policy should coordinate the strategies for new and existing buildings so that the largest impact can be created. For regulatory control, it is believed that the starting point is in new buildings. But, the challenge is in existing buildings because of the size of the stock and because systems change and need replacement periodically. To overcome the financial barriers in retrofitting existing buildings, incentives may be provided from other sources (such as the building improvement loan of the Housing Society and Urban Renewal Authority) and innovative financing techniques (such as energy performance contracts) may also be used. The voluntary HKEERSB based on benchmark data could be promoted further to existing buildings and some incentive programmes might be considered to encourage retrofitting of the existing buildings to achieve code compliance. An energy efficiency improvement assistance scheme (like the one in Singapore) can be considered for this purpose.

3.1.2 Demonstration and Incentives

BEC enforcement needs to be demonstrated, for at least some buildings, both before and after construction. If buildings designs and constructed buildings are found to not be in compliance, then they must be cited and required to comply or respect for the mandate will be lost. Demonstration projects can be found in many of the countries reviewed and they may include both government's and private-sector's buildings.

Experience also shows the benefit of adopting specific measures to encourage and to track compliance enforcement. One approach used is to require detailed compliance reviews for at least 10% of the floor area constructed or 10% of the buildings constructed (whichever is larger). Another approach is to publicly document enforcement results. These compliance reviews would be published in the public record periodically, along with a record of the actions taken on specific building projects in the case of non-compliance.

Several enforcement approaches encourage compliance using positive incentives. The following incentives for compliance may prove beneficial:

- Monetary awards for surpassing compliance by some amount
- Public notification award for surpassing compliance by some amount
- Award of labels of achievement to buildings
- Subsidized technical assistance

Providing incentives for complying with the BEC, and for surpassing the code by 10% to 30%, are measures that are widely used in conjunction with BEC. Normally, such measures have been part of electric utility incentive and rebate programs, but some measures such as the US EPA "Energy Star Building" award and labeling program, have been accomplished by government agencies. Penalties and incentives used in combination can be especially effective, with penalties used to ensure compliance with the minimum requirements of the BEC, and, at the same time, incentives used to encourage the design and construction to go beyond those requirements.

3.2 Public Sector

All new government projects and major retrofit work have already participated in the HKEERSB. It is believed that the public sector can act as a market driver and lead the private sector in the key aspects of energy efficiency.

3.3 Major Barriers and Limitations

A barrier is a postulated mechanism that inhibits investment in technologies that are both energy efficient and (apparently) economically efficient (also known as the "efficiency gap"). From the results of our local review and assessment (see also the Research Report), it is found that the major barriers affecting energy efficiency improvement in Hong Kong are the financial aspects (long payback, high investment cost and budget limitation) and inadequate education and awareness.

In order to determine an effective strategy for resolving and overcoming the barriers, a sound understanding of the market barriers to be addressed and a realistic assessment of the likely effectiveness of a policy are required. Table 3.3 shows the major barriers to energy efficiency in buildings, which are classified into four main categories: structural, technical, financial and cultural.

Improved energy efficiency at the society level has to occur through a thoughtful, planned approach over a fairly long period. Due consideration to the factors that are hindering the market from functioning properly need to be examined. And governments have to continually assess whether their measures are properly targeting those barriers.

Table 3.2 Major barriers to energy efficiency in buildings

Category	Examples of the barriers
Structural	Government fiscal and regulatory policies Legislative barriers Distortions in energy prices Organisation and coordination Ownership problems Supply infrastructure
Technical	Hard to measure/monitor Lack of information Lack of skill and knowledge Lack of trained personnel or managerial expertise
Financial	Financing problems High initial cost High operating cost Limited access to capital Low return on investment Perceived risks of energy efficiency investments
Cultural	Attitudes toward energy efficiency Awareness No incentives Lack of market signals

3.4 Policy Options

At the Research Stage of this study, a number of policy options have been considered and studied, with the aim to evaluate and identify an appropriate strategy for implementation. By comparing with the experience in other countries and considering the local context, the important issues for policy design are examined. The possible options for future development of the BECs in Hong Kong are considered in four perspectives and the preferred option is recommended.

- Mandatory or voluntary (Stick and carrot)
- Target types of buildings
- Framework of control
- Statutory requirements

3.4.1 Mandatory or Voluntary

It is important to decide if the BECs will be changed from a voluntary compliance to a mandatory system. The main considerations include the effectiveness of voluntary measures and the impact of mandatory BECs. It is expected that the policy decision will be made by the relevant government body.

Our research results show that the participation in the voluntary HKEERSB is rather low and the private sector is reluctant to adopt the BECs because of split incentives - owners/builders incur costs while occupiers reap the benefits, and lack of full information on which to make sound decisions. If the Hong Kong SAR Government concludes that BECs should be adopted, then it is believed that mandatory BECs are most effective at realizing the advantages that codes produce. In parallel with mandatory or regulatory BECs, it is also suggested that the information and education services for the BECs should be improved so that the stakeholders are better informed.

3.4.2 Target Types of Buildings

It is necessary to select the main target types of buildings for the control action. From the technical assessment of building stock in Hong Kong and evaluation of their energy saving potential, it is believed that commercial buildings (including offices, retails and hotels) should be the main focus and target group. It is because they are the most significant sector of energy end-use and will continue to grow due to the service-oriented economy in Hong Kong.

If other types of buildings or parts of them have energy characteristics similar to commercial buildings, then it is possible to apply a similar regulatory control method at this stage. For example, the common areas of residential and industrial buildings could be included in the regulatory control action.

The experience in Europe and USA shows that building energy certificate or label scheme is useful for the residential sector and can create market effects to better inform the building users. In Hong Kong, since the private and public housings are the main investments of the citizens, some forms of building energy labels will be useful to give prospective owners or tenants better information on the energy costs and performance of the building or apartment. The labels can also include recommendations for improving energy performance. More information about the worldwide experience of building energy label can be found in Chapter 3 of the Research Report.

Judging from the worldwide experience and current Hong Kong practice, it is believed that the mandatory BECs in the beginning should be applied to new buildings only because the existing buildings cannot be modified quickly to meet the modern energy efficiency requirements. The focus should be on commercial buildings (including offices, retails and hotels) and the common areas of residential buildings and industrial buildings. The voluntary HKEERSB based on benchmark data could be promoted further to existing buildings and some incentive programmes might be considered to encourage retrofitting of the existing buildings to achieve code compliance.

3.4.3 Framework of Control

The legislative framework provided through the Laws of Hong Kong is an important foundation for the energy efficiency efforts. If the mandatory BECs approach is accepted, there are three options for setting the framework of control legislation in Hong Kong:

- Option 1 – Incorporate in the existing Building (Energy Efficiency) Regulation under the Building Ordinance
- Option 2 – Establish a new Ordinance and Regulation on mandatory BEC
- Option 3 – Amend and attach to the proposed Energy Efficiency (Labeling of Products) Ordinance

These three options are considered after reviewing the worldwide experience and local context, including consultation with EMSD. Their legal, political, societal & fiscal implications shall be reviewed carefully by EMSD and the Department of Justice.

Option 1 has the advantage of a holistic building energy control under one ordinance covering both building envelope and building services installations. This is similar to the Singapore practice, as well as the practices in Australia and UK. With the authority of withholding the issue of occupation permit (OP), the energy efficiency requirements could be enforced effectively. Also, as the ordinance is already in place, the stakeholders customary to the existing control framework are likely to support this arrangement that involves less changes. However, the purview of the Building Ordinance is for setting minimum health & safety standards and providing the authority for enforcement, and the Buildings Department, charged with the mission on building works that are of a “brick & mortar” nature such as columns, beams & slabs, but not on building services installations, has been trying recently to depart from the control of building environmental issues, as in the case of the CEPAS. Given this background, there may be difficulty in obtaining adequate support in the amendment of the Ordinance. Whilst withholding OP may be an effective means of enforcement, such penalty on non-safety related matters may be considered excessive and attract strong opposition from developers & business enterprises who demand prompt occupation. There are also complications in defining building services installations under the building works environment of the ordinance, and, as the ordinance has focused on new buildings, difficulties to control existing building services installations in existing buildings.

Option 2 has the advantage of flexibility in penalization, by not involving OP and setting at levels more acceptable to developers & business enterprises, as the energy efficiency requirements are not safety oriented. Under a complete new ordinance not over-shadowed by precedent one, the buildings services definitions & requirements on energy performances of relevant installations can be clearly defined & stipulated, which could be more readily realized by the building services designers and stakeholders. There is clear demarcation of authority in the different work regimes – building services installations under EMSD, and building works under BD. There is the flexibility on imposing amendment or additional requirements or imposing requirements on existing buildings in future. The new ordinance approach has also been in practice in Thailand. An added advantage is the strong commitment of the EMSD on energy efficiency & conservation, and its strong expertise and reputation in the building services field & energy field. However, the new ordinance will involve considerable time and resources in drafting, and the stakeholders might perceive the new legislation as complication when compared to the existing operation under the single ordinance as they have to lodge submissions to two departments instead of one.

Option 3, by nature of it being a separate ordinance, has the benefits of Option 2 as well as its disadvantages when compared to Option 1. It also has the advantage of a holistic energy efficiency ordinance covering all matters relating to energy efficiency & conservation, including products, installations, building materials etc. Under the holistic ordinance, a clearer energy policy is viable for targets setting on overall energy efficiency & conservation in the community. There is also the flexibility to impose requirements for other energy consuming regimes such as vehicle fuels. However given its likely enactment in the near future, an amendment within a short time may not be politically advisable. Also the complication involved in transferring the control of OTTV from BD would affect its intended scope of holistic control on energy efficiency & conservation.

Further analysis should be done to clearly assess the impacts and benefits of the options.

3.4.4 Statutory Requirements

Statutory requirements refer to the level of compliance. When the BECs are linked up with statutory requirements, it is important to design suitable strategy to gradually build up the confidence of the stakeholders and enhance their acceptance. From the worldwide experience, there are three choices of the statutory requirements:

- Choice 1: report performance only, i.e. to declare if the building complies or does not comply
- Choice 2: both comply and report, i.e. to comply and declare compliance
- Choice 3: report certified rating, i.e. to declare the building's energy performance based on established building energy labeling or rating system

Choice 1 and Choice 2 are closely related. If needed, they can be combined to represent the minimum BEC requirement. Attention should also be made to the coordination of other policies, such as appliance energy standards/labels, energy auditing and benchmarking, and energy efficient building awards.

Choice 3 could only be taken in the future when the building energy labeling system is well established.

3.5 Cost and Benefit Analysis

Analysis of the potential energy effect and cost-effectiveness of the BECs is a complicated task. The outcomes depend very much on the objectives set out at the very beginning and the assumptions made for the estimation. At present, no attempt is made to carry out a comprehensive analysis of the costs and benefits because this is beyond the scope of the present study. However, initial analysis and assessment about the energy saving potential of the BECs have been done to help find out the direction and identify key segments for the policy planning and further analysis.

3.5.1 Evaluation of Energy Saving Potential

The commercial sector is the most important component in the energy end-use in Hong Kong. The residential sector also has good opportunity to promote energy efficiency. However as the energy consumption in residential units are from appliances such as room air conditioners, computers, refrigerators, compact fluorescent lamps etc., which are covered by EMSD's initiative The Hong Kong Voluntary Energy Efficiency Labelling Scheme, the promotion of BEC in these tenant units has not been included in this study.

The evaluation and estimation of energy saving from mandatory BEC is given below.

Table 3.3 Estimation of energy saving

Building Types	Existing Energy Consumption MkWh/Yr) (2004)	Estimated Energy Saving from BEC Compliance	
		New Buildings only (MkWh/Yr)	New & Existing Buildings (kWh/Yr) (Full Penetration)
Private Offices	3,979	13.4	596
Retails	11,393	35.9	2,848
Industrial (communal areas)	4,472	1.87	670
Hotel	1,499	1.1	32
Residential (communal areas)	441	1.9	110
Total	21,785 (27% of total HK)	**54** (0.07% of Total HK)	**4,258** (5.3% of Total HK)

Note: The energy figures are based on EMSD's publication the "Hong Kong Energy End-use Data, 2006", and the additional building area & hotel rooms are based on the average increase in the coming years indicated respectively in the "Hong Kong Property Review, 2007, Rating & Valuation Department", and information at the website of the Hong Kong Tourism Board.

These five types of buildings have accounted for 27% of the total end-use energy consumption in Hong Kong, with a potential energy saving of 54 MkWh per year if; mandatory BEC is implemented for new buildings only. The full potential saving could reach 4,258 MkWh per year at full penetration of BEC compliance to existing buildings as well.

3.5.2 Assessment of Costs and Benefits

The cost associated with each energy saving measure is usually taken as the incremental cost over a base-case specification. It should be noted that construction cost increases and energy savings will vary depending on many factors including energy prices, building size and characteristics, material costs, labour costs and the energy efficiency measures used to comply with the BECs.

The current BECs have been stipulating requirements readily compliable with equipment & materials commonly available in the market and trade. Items in compliance generally bear only slightly higher but very comparable costs. What the building industry lacks is a concerted approach towards energy efficiency, and the mandatory approach on BEC compliance is facilitating the approach. The mandate provides the routinization of procurement of BEC-compliant items such as luminaries, chillers, motors, lift machines etc. and design of systems to incorporate lower losses and enhanced controls, the additional costs of which are minimal if incorporated at the early design stage, and involves in general only a few percent of the entire building cost.

If a comprehensive cost-benefit analysis is carried out, the following issues should be considered.

- *Analysis of costs*. The costs of the policy that are analysed shall be the real resource costs. This means the materials and manpower used for new investment (and financing costs). It included up-front costs and ongoing running costs, including marketing. This definition also included administrative costs incurred by government, its agencies and the firms and people affected by the policy.
- *Analysis of benefits*. Benefits shall be counted as welfare-enhancing or harm-reducing

activities that are additional to business as usual. The benefits for the policy include, typically, reduced energy consumption, reduced emissions of carbon dioxide, and increases in security of energy supply. For energy efficiency there is also comfort taking e.g. enjoying a more comfortable built environment.

To the extent possible a monetary value shall be given to all key benefits. These are partial equilibrium analysis of individual policy options. They do not model explicitly the general equilibrium or macroeconomic effects that implementation of one or more of these options may have.

4. POLICY DESIGN AND PLANNING

Policy design and planning will determine how the BEC performs in actual situation. In this study the critical issues of policy design & planning have been examined and discussed in this Chapter.

A BEC can be effective only if it is properly enforced and accepted. Some building designers and owners might be forced to follow the code because of the fear of non-compliance penalties (such as stop occupancy or construction). However, a much larger population will be interested in measures that promise paybacks and/or enhance their competitiveness. It is a fact that construction is primarily a market activity, the quality of whose products reflect the interplay of costs, time, availability of materials, skill and knowledge. Only if the BEC become a criteria in the market-oriented decision-making process, can they be successfully established in the society.

4.1 Market Conditions and Requirements

Energy efficiency opportunities are more widespread and cost effective prior to construction of buildings, so policies such as BEC that focus attention on these opportunities during the design phase are especially advantageous. Other energy conservation programmes like incentive scheme, energy audit, voluntary best practice initiatives and publicity are important from the market point of view. The strategy for market stimulation and information should be designed to support the BEC implementation.

4.1.1 Responsibility and Authority

Experience from other countries show there should be clearly defined roles, responsibilities, and unequivocal authority given to one or more organizations to carry out implementation activities for the BEC. There is no one best model for how to structure various implementation roles and responsibilities; it depends on the circumstances particular to each situation. No entity should be assigned responsibility without being given the commensurate authority to effectively carry it out. Typically the administrative oversight function is carried out by an organization whose charter is buildings or energy efficiency. The enforcement function is often carried at a local level by building code officials already responsible for health and life-safety. The code evaluation and revision function is typically carried out by research institutes or consultants. It is not necessary, or necessarily even desirable, that the entity that implements the BEC would be the same entity that developed the code, or that would evaluate implementation results or would manage the effort to revise the code. No matter how the roles are divided, the best successes occur when each of the entities are active in conducting their own roles in close coordination with the others, working towards achieving common objectives.

It is important to define clearly the institutional requirements for the code and provide clear guidelines on responsibilities and authority. At present, in Hong Kong, there are two government departments involved in the BEC work.

- Buildings Department (BD): administers the OTTV Code
- Electrical and Mechanical Services Department (EMSD): manages the other five BECs

Considering the calculation of the OTTV Code and technical requirements of the other BECs, it is believed that EMSD's role is very essential for the code enforcement and implementation. Starting from 1 July 2007, both BD and EMSD are grouped under the Development Bureau of the HKSAR Government. It should not be difficult for the two departments to coordinate and agree on the defined roles to facilitate the implementation of a comprehensive BEC.

4.1.2 Education and Information

Education and information is crucial for creating a better understanding of the BECs among the stakeholders. It is important to develop the basic education and training for the relevant professionals so that they have sufficient skills for applying the BECs. It is also necessary to provide education to major stakeholders and general public so that they can understand the rationale and support the policy.

Overseas experience indicates that acceptance and understanding of the code can be improved by providing proper training to architects, engineers, building owners and developers, equipment suppliers and other key building decision-makers, such as bankers, real-estate agents, builders and sub-contractors. Other marketing activities for the BEC may include:

- Workshops at association meetings
- Public seminars and workshops
- Direct mail
- Circulars to professional bodies
- Newsletters
- Internet website
- Demonstration projects

Appropriate information to consumers, decision-makers, the energy service sector, architects, engineers, distributors and others in the energy efficiency field ensures that more of the cost-effective potential is achieved. Information programmes cover a wide spectrum from mass media campaigns, information centres, training, technical manuals and brochures, labelling and energy audits. They can be used for awareness creation or for providing detailed information to various actors: consumers, equipment operators/technicians, managers of building complexes, engineers, architects and decision-makers.

Awareness creation is a key consideration because many consumers in all end-use sectors have little understanding of the cost-effective potential for improvements for energy efficiency or of the techniques to make such improvements. Awareness creation is also important for service providers (e.g. auditors) to show the market potential available. It is possible to use existing organisations to help disseminate the information. These include, for example, professional organisations such as engineering societies, green groups and non-governmental organisations (NGOs).

Training is also important because it is necessary to ensure that specialists or would-be specialists in energy efficiency have access to the most recent material on techniques and technologies to improve energy efficiency. The speed of technology shifts is increasing and technologies are becoming more complex. If needed, technical assistance programme could be provided by the government to support the code compliance and submission procedure.

4.1.3 Smart Regulation

Many of the BECs in the world are developed through some sort of consensus process through public consultation. Stakeholders consider a diverse array of issues before adopting a code, including technical efficiency, practicality, and cost-effectiveness. Because of the accommodation made to differing perspectives, adopted codes are considered by some to result in buildings that have less than ideal energy efficiency. However, the stakeholder process ensures that the results are useable and reasonable within the building community as a whole. Above-code guidelines such as energy design guides and green building rating systems act to identify the next generation of efficiency practices that, after considerable experimentation and adoption, may become code through a stakeholder process.

Nowadays, the challenge for regulators in Hong Kong is to protect public interest while providing the conditions for a vibrant economy to flourish (Tang, 2006). Obviously, the major benefits of the BECs are with public interest and the interest of the end-users or tenants. Therefore, a “smart regulation” process is needed to motivate the stakeholders and ensure the outcomes.

In order to convince people to accept the control regulation, a wide consultation is needed. Appropriate measures are required to streamline the code compliance process and promote the importance of energy efficiency at all levels of the society. Good justification and evidence are essential for sustaining such control in a free-market condition, like the one in Hong Kong.

4.2 Policy Implications

The move to change the voluntary BECs into mandatory requirements requires the support from the community and the related stakeholders. It is believed that our society is in favour of policy measures that could contribute to energy efficiency and environmental protection, because the awareness of environmental pollution and sustainability has increased significantly as compared to a few decades ago. The implementation of BECs is an effective method to control and promote energy efficient building design and operation, and they should be able to receive supports from various different sectors in the society.

Nevertheless, from the past experience in Hong Kong on public affairs, the legislation process for such type of control regulations will not be so straightforward because the skepticism and reluctance of some stakeholders will affect the final decision of the legislators. If some people are skeptical about the benefits and costs of mandatory BECs, it will create obstacles to the legislation process and delay the decision. Therefore, the policy design should consider appropriate instruments and their implications.

4.2.1 Policy Instruments

A range of policy instruments can be used to achieve the energy efficiency policy objectives. A list of them that can be used to advance energy efficiency for the private sector is shown below.

- Policy statements and guidelines
- Information
- Education
- Financial incentives
- Regulations and standards
- Voluntary measures
- Research & development (R&D)

Usually a combination of them will be used for the energy efficiency strategy, although some countries tend to emphasise one over the other. In general, the policy instruments can be divided into two categories: financial and non-financial.

The financial instruments for energy savings include funds, subsidies, grants, tax rebates, loans, third-party financing, energy performance contracting, guarantee of energy savings contracts, energy outsourcing and other related contracts that are made available to the market place by public or private bodies. These instruments will help to cover partly or totally the initial project cost for implementing energy efficiency improvement measures. They are generally well targeted to meet specific objectives and are also developed to:

- Improve the access to capital
- Break the inertia to motivate consumers to take energy efficiency actions
- Improve the cost-effectiveness of innovative energy-efficient technologies

Non-financial or fiscal policy instruments are the general instruments used by governments or government bodies to create a supportive framework or incentives for market actors to provide and purchase energy services and other energy efficiency improvement measures. Practical examples of them include:

- Planning and zoning laws
- Building codes (new, retrofits, existing)
- Rating, accreditation schemes (labeling, disclosure)
- Equipment/Appliance standards (lighting, motors, standby, etc)
- R&D, demonstration
- Market transformation initiatives
- Voluntary initiatives

4.2.2 Measure of Achievement

There are many ways of defining success of BEC, some obvious and relatively straightforward to measure (albeit possibly involved and costly), and others more subtle and difficult to measure. However, it should be noted that measurability does not correlate with the importance of any particular indicator of success. Depending on the goals set out for the code by any given jurisdiction, indicators of success will vary. Some indicators could include (shown roughly in order of increasing difficulty to measure):

- Use of standard as a performance benchmark
- Level of compliance
- Energy and energy cost savings

- Falling life-cycle costs for buildings
- Extent of buildings exceeding the BEC
- Shift in building practice, including designs and equipment specified
- Fosters integrated design process with enhanced communication and coordination between architectural and engineering designers
- Awareness of BEC and energy efficiency opportunities

While the design codes for the construction of buildings set parameters for energy consumption over the life span of the building, the subsequent operation and maintenance of the building, for example its centralised air-conditioning plants are equally important. These plants can typically account for 60% of the electricity bills of the buildings. Badly commissioned and maintained plants can inflate energy consumption significantly. Promoting energy audits of all buildings will allow the success of BEC or any other policy to be measured “on site” and compared against a benchmark. Auditing activities can also provide useful information for identifying energy conservation opportunities that designers may not have think of. Continued effort is required to monitor performance of the building, and whenever appropriate, propose improvement measures to the building manager or owner.

4.3 Legislative Framework

To legislate a BEC, a substantial amount of efforts would be needed for establishing the implementation mechanism and procedures, delineating the relations with the existing Building Regulations, defining the responsibilities of the building professionals and for drafting the associated laws/ordinance. There is no hard and fast rule since the success of the code depends not only on how it is designed and coded but also on how it is implemented and publicised.

4.3.1 Current Hong Kong BECs

Figure 4.1 shows the framework of the comprehensive BEC established in Hong Kong. It consists of two compliance paths (prescriptive approach and performance approach).

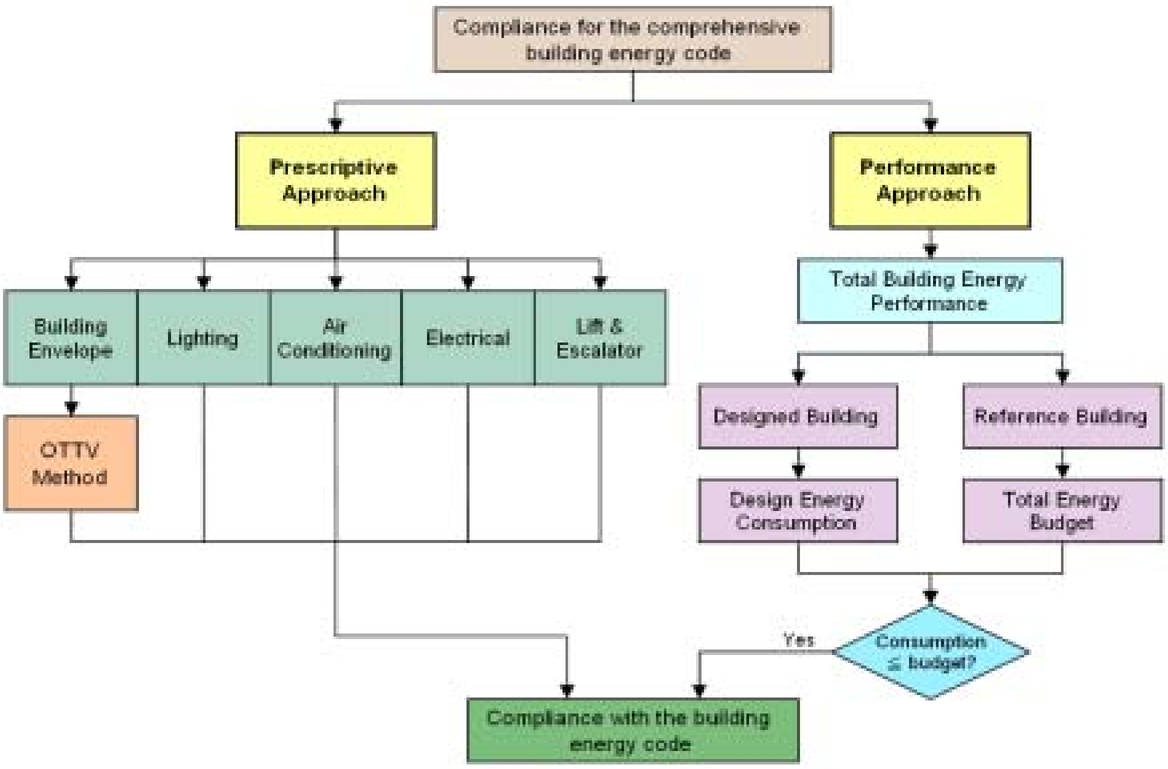

Figure 4.1 Framework of the comprehensive building energy code in Hong Kong

One drawback of the current framework is that the BECs are isolated and not well coordinated with the OTTV code. To optimize the combined performance of the building systems, it is important to consider the interactions between them. Integration of building systems and cost-effective trade-offs in design should be facilitated to achieve higher energy efficiency in buildings.

4.3.2 Proposed Regulatory Framework

From Section 3.4.3 there are three options for designing the legislative control framework. Figure 4.2 shows the three possible settings of the regulatory framework for the BECs in Hong Kong.

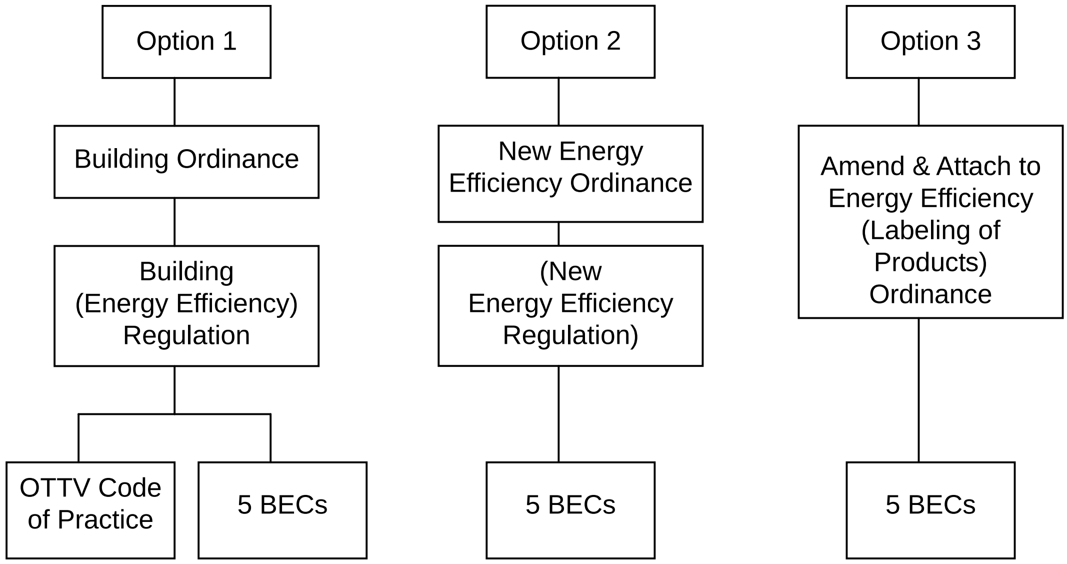

Figure 4.2 Proposed regulatory framework for building energy efficiency in Hong Kong

4.4 Enforcement and Control Methods

After building standards laws are approved, it is necessary to have strong implementation, training, and enforcement programmes to realise their potential benefits. There are two main considerations at this stage:

- Code Enforcement – limits the number of buildings falling below the current energy code
- Code Revision – gradually increases the requirements that all buildings must meet

4.4.1 Stringency Levels

Stringency is a key implementation issue. No matter how effective the implementation programme is, if the BEC is not pitched at the appropriate stringency level, it will be perceived as ineffective and a waste of resources. The level of performance expected must take into consideration the achievability of the stringency levels as well as the cost implications. The role of BEC is to define the minimum levels of efficiency, or maximum levels of energy consumption. However, what is an acceptable minimum cannot be determined solely by technical analysis. The setting of these levels requires social and political negotiation.

Stringency levels are most effective and respected when they are based on cost effectiveness analysis, balancing the socio-economic perspective and the financial perspective of the building owner. On the other hand, stringency levels may need to be tempered by consideration of several potent barriers to substantial increases in building energy efficiency including:

- Availability of energy efficient products in the marketplace
- The desire to maintain the competitiveness of local manufacturers
- The current levels of energy efficiency skill and knowledge by local design professionals

Generally speaking, two approaches are commonly used to determine the stringency level of BECs, namely:

- An engineering economic approach
- A statistical approach

4.4.2 Code Revision

It is vital that BECs be continually revised, as more efficient equipment becomes available. Without continued revision, the market might actually be held back by the widespread view that code represents appropriate design practice. It is always important to keep abreast of the latest technical knowledge and developments, by regularly reviewing and updating the BEC and its stringency requirements. Usually, if the policy instruments are implemented correctly, benchmark performance values can be raised incrementally with each review, pushing higher and higher performance or energy efficiency for the society.

It is advisable to discuss and find out suitable approach for setting the stringent level and agree on schedule and timetable for future code review and revision.

4.4.3 Code Compliance Process

Complexity in the compliance process has a very negative impact and should be avoided. It is best to develop and disseminate a set of compliance procedures, forms, manuals, and tools that clearly describe what compliance documents are to be submitted, by whom, to whom, and when.

Including substantial participation by members of the building industry that will ultimately need to use the products will help ensure that the compliance process is kept simple, and that the products are clear and easy to use.

In prescriptive form, this experience can be stated as follows:

- Compliance procedures should be clearly defined in detail. They should be as simple as possible and segregated by size of building, with the smallest buildings having the simplest procedures.
- Compliance procedures and forms should be fully explained and documented in compliance manuals.
- All compliance procedures, forms and manuals should be field tested on one or more real buildings under design of different sizes and types (e.g., office, retail, hotel).

The development and provision of code compliance software tools could help to simplify the compliance procedure and shorten the assessment process and certification time. The organisation and setting up of formal BEC training courses and educational information could enhance the ability of the practitioners and promote better skills in energy conservation. This is especially essential for the Performance-based Code that people find it quite complicated to operate at present.

4.5 Impact Assessment

If a mandatory implementation is adopted for the BECs in Hong Kong, it is necessary to carry out an impact assessment to evaluate the recommended approaches. In order to understand the process, investigation has been done to study the experience in other countries. It is found that when developing their BECs, Australia, UK and USA have carried out impact assessments through independent research and consultancy studies. The EU has also published guidelines on impact assessment so as to help its member countries to adopt such and approach.

Appendix II gives the recommended methodologies on impact assessment and provides further information and references to follow the systematic procedure.

5. CONCLUSIONS

This report explains the major outcomes at the Development Stage of the “Study on Enhanced Promotion of Building Energy Codes in Hong Kong (EEO/Q284)”. The report follows the line of thought of the research results obtained in the previous stages and evaluates critically the strategies for future BEC development.

5.1 *Local and Worldwide Reviews*

Analysis of the local situation in Hong Kong indicates that the current voluntary HKEERSB is limited by the market factors and the participation of private sector is rather low. The main reasons for this are the lack of motivation and the existence of market barriers. It is believed that the existing BECs, with three approaches (prescriptive, performance and benchmark data), can provide enough flexibility for people to consider suitable strategy to achieve better energy efficiency in their buildings. But the code implementation and promotion strategy could be improved so as to streamline the assessment and checking processes.

Review of the worldwide BEC strategies and experience is useful to Hong Kong. For instance, evaluation of the Singapore approach, EU Directives and “push and pull” principle can provide insights into future developments of BEC. BECs could play a crucial role in raising energy efficiency in the market, and with its higher adoption, there would be significant potential for energy savings in the building sector, the existing buildings in particular.

5.2 *Regulatory Options*

Without the mandatory BECs, architects and builders are under pressure to minimise investments in energy efficiency to hold down the initial cost of the buildings, even when the additional investments would be repaid rapidly through lower energy costs. It is believed that mandatory BECs are more effective for implementation than voluntary one and it could help to overcome the market failure in the provision of energy efficiency especially in the commercial sectors.

Different regulatory options have been considered and studied. It is found that the starting point is in new buildings. But, the challenge is in existing commercial buildings because of the large size of the stock and their frequent retrofit work due to change of tenancy and usage. The main recommendations are summarised below.

- A mandatory BEC system is preferred
- Focus the control actions on commercial buildings (including offices, retails, hotels, communal areas of residential and industrial premises)
- Three options for the mandatory or regulatory framework
    - Option 1: Incorporate in the existing Building (Energy Efficiency) Regulation under Building Ordinance
    - Option 2: Establish a new Ordinance/Regulation on mandatory BEC
    - Option 3: Amend and attach to the proposed Energy Efficiency (Labeling of Products) Ordinance
- Consider strategy to gradually build up the confidence of the stakeholders, including
    - vigorous demonstrations in government/public buildings of BEC compliance and
    - joint programmes with professional institutions & trade organizations on how to achieve BEC compliance.
- Set up consistent energy audit system
- For statutory requirements, gradually take
    - Choice 2 – to comply with BEC & declare

5.3 *Policy Planning and Impact Assessment*

As for policy design and planning, the following key issues have been discussed and practical advice is provided in this report.

- Responsibility and authority
- Education and information
- Consultation and lobbying, including building industry stakeholders, body corporates and small to medium enterprises who are owners or users of tenant units in buildings
- Policy instruments

- Measure of achievement
- Legislative framework
- Stringency levels
- Code revision
- Code compliance process

Finally, the basic principles of impact assessment (IA) are elaborated and suggestions are provided on how to carry out the IA systematically.

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