

**A Review of Overseas and Hong Kong Energy Efficiency Policy for Low
Carbon Buildings in the Urban Environment**

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ABSTRACT

In the HKSAR Chief Executive Policy Address 2010-2011, the Hong Kong Government has set the goal of reducing carbon intensity by 50-60% by 2020, compared with 2005 level. According to government statistics, greenhouse gas emissions arising from electricity consumption contributes to 67% of the total emission, where over 89% of this is due to electricity usage in buildings. It is thus of vital importance to enhance energy efficiency in buildings in order to achieve any meaningful carbon reduction.

In this paper, best practices and successful overseas cases were identified and analysed. Policies with particular merit in apply to Hong Kong's urban environment were selected and an online survey has been conducted to gauge public acceptance on the selected policies. Results suggested that the general public supported promotion of energy efficiency as a whole with a preference towards policies that are simple and with immediate financial benefit. We concluded this paper by recommending a set of measures to improve the energy efficiency performance in Hong Kong though better institutional setting; providing financial incentives for energy conservation equipment; stepping up education and promotion; supporting market development for energy saving lamps and offering rebate for high efficient cooling systems.

Key words: energy efficiency, Hong Kong, low carbon, building, policy

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Introduction

From the HKSAR Chief Executive Policy Address 2010-2011, Section D – Combating Climate Change, Hong Kong is committed to enhance energy efficiency, promote green building, advocate electricity saving, facilitate low-carbon transport and develop waste-to-energy facilities. Under this policy Hong Kong aims to reduce carbon intensity by 50-60% by 2020, compared with 2005 level. According to the government, greenhouse gas emissions will decrease by 19-33% compared with 2005. Emissions per capita will also be lowered from 6.2 tonnes to 3.6-4.5 tonnes, far lower than the levels of the United States, the European Union and Japan (HKSAR, 2010).

In this paper we carried out a literature review for the current applications of various green building policies in Hong Kong and overseas countries, including US, Europe, Japan, Singapore and Taiwan. We have identified that 89% of the total electricity consumption in Hong Kong is due to building usage (EMSD, 2010) which contribute 67% of the total Greenhouse Gas emission in Hong Kong (EPD, 2010), leading us to focus our analysis on various applications on equipment and measures in green buildings.

Overseas successful cases and best practices were identified and an online survey was conducted to gauge public acceptance on the selected policies. We concluded this paper by discussing and recommending a set of suggestions including enhancement of the current institutional setting; financial incentives for energy conservation equipment; education and promotion for public awareness of energy conservation;

development of market for energy saving lamps; and rebate of high efficient cooling system.

Methodology

Publications made by the Energy Efficiency Office of the Electrical and Mechanical Services Department and the Environmental Protection Department were reviewed to analyse the current policies of Hong Kong, this includes annual reports, surveys, code of practice, guidance notes and guidelines. Besides, a literature review was carried out on overseas experience of US, EU, Japan, Singapore and Taiwan from academic journals, reports, and relevant government websites. Additionally, an online survey was conducted to gauge public acceptance of some selected energy efficiency policies amongst Hong Kong citizens.

Literature Review and Current Situations

In the process of planning and implementing energy efficiency programmes, some common obstacles were well recognized, including market, financial, informational, institutional and technical barriers (International Energy Agency, 2010). Providing incentives and supports in the forms of government subsidies or making use of market mechanisms are important elements in enhancing the establishment of renewable energy systems (Elliott, 2007), similar strategies are also applicable for energy efficiency.

Hong Kong Situations

Energy Efficiency Office

The Government has established Energy Efficiency Office in 1994 under the Electrical and Mechanical Services Department (EMSD) to provide the technical expertise and promote energy efficiency and conservation in Hong Kong. According to the booklet "A Decade of Energy Efficiency and Conservation" (Energy Efficiency Office, 2004), there are six major areas of work of the Office. It is responsible to develop and operate voluntary registration programmes such as the energy labelling schemes and pilot scheme for cooling towers. For energy management, the Office promotes best practices to both the public and private sectors, which includes energy audits, assisting government departments to achieve energy saving targets, and monitoring the demand-side management activities of the two power companies. Moreover, an Energy End-use Database was constructed, which monitors energy consumption patterns in Hong Kong. The data is made available annually and has become a useful resource for assisting in strategise energy saving plan and programmes. The Office also pioneers the use of advanced energy-efficient systems and technologies, such as T5 lighting system. For alternative energy, new and renewable energy options are explored through studies, demonstration projects and measurement projects of various renewable energy sources to investigate the application feasibility for Hong Kong. To heighten public awareness and the importance of energy efficiency, the Office has been commissioned to develop standards and guidelines for the trade, provides practical energy saving tips, and issues codes of practice such as the Building Energy Code.

Mandatory Implementation of Building Energy Code

A series of Building Energy Codes (BECs) has been published by the Electrical & Mechanical Services

Department (EMSD) since 1998. The BECs stipulate the minimum energy efficiency requirements for the four major energy consumption areas in a modern office building, which are air-conditioning system, lighting, electrical and, lift and escalator, since about 80% of the total electricity consumption is due to these four types of building services installations (EMSD, 2011b). In order to promote compliance with the BECs, the voluntary Hong Kong Energy Efficiency Registration Scheme for Buildings has also been introduced in 1998 (EMSD, 2011c). Due to the low participation rate of the private sector to the Voluntary Registration Scheme, the Government proposed to mandate compliance of the BECs by legislation in 2009. The legislative framework of the BEC for the mandatory scheme and the Energy Audit Code are based on the existing BEC for the voluntary scheme and Guidelines on Energy Audit respectively. The Buildings Energy Efficiency Bill for mandatory implementation of the BEC was passed to become the Buildings Energy Efficiency Ordinance (Cap. 610) and was published on 10 December 2010. The Ordinance (except Parts 2 to 6) will be brought into force on 21 February 2011. When the vetting of the subsidiary regulations on the fees and registration of Registered Energy Assessor (REA) under the this Ordinance is completed by the Legislative Council, it is expected that the full implementation of the Buildings Energy Efficiency Ordinance (Cap. 610) will commence in mid-2012.

Mandatory and Voluntary Energy Efficiency Labelling Scheme

The Electrical and Mechanical Services Department has launched the Mandatory and Voluntary Energy Efficiency Labelling Scheme (MEELS and VEELS) for appliances and equipment used in the home and

office (EMSD, 2011a). By providing information about energy consumption and efficiency, it is expected that consumers will be able to make better decisions on purchasing better energy-saving devices, thus promoting such devices through market demand.

VEELS covers eighteen types of household appliances and office equipment, such as refrigerators, non-integrated type compact fluorescent lamps, room coolers photocopiers and computers. Since 9 November 2009, MEELS has been fully implemented through the Energy Efficiency Labelling (Labelling of Products) Ordinance (EMSD, 2011a). The initial phase of the MEELS covers three types of products, which are room air conditioners, refrigerating appliances and compact fluorescent lamps. Reference numbers and energy labels are required to be listed on these products. On 19 March 2010, the second phase of the MEELS commenced which extends the coverage to two more electrical appliances which are washing machines and dehumidifiers.

HK Energy Efficiency Registration Scheme for Buildings

In October 1998, HK Energy Efficiency Registration Scheme for Buildings has been launched by the Electrical & Mechanical Services Department (EMSD, 2011c). Designers, architects, building developers, property management agencies etc. can submit details of their building to participate in this scheme. Existing buildings with good energy performance and energy-audited can be registered in the “Registration Scheme” if they can fulfill certain criteria. "Energy Efficient Building Logo" can be added on related documents of a registered building to show their achievement on energy efficiency. A total of 2795 registration certificates were issued to 1216 building until December 2010.

Energy Audit

The Electrical & Mechanical Services Department provides “Guidelines on Energy Audit”, setting out the requirements on energy audit for commercial buildings targeting the situation of commercial building in Hong Kong in particular (EMSD, 2007b).

Building Energy Efficiency Funding Schemes (BEEFS)

On 8 April 2009, Hong Kong Government formally launched a \$450 million Building Energy Efficiency Funding Schemes with funding from the Environment and Conservation Fund (Environment and Conservation Fund, 2011). There are two projects under the Funding Schemes. Firstly, the Energy-cum-carbon Audit Projects (ECA) which encourage building owners especially residential and commercial buildings to carry out carbon audit, a limit of 50% of the total expenditure spent for the audit and subsequent reporting will be subsidized and the maximum of total government subsidy is HK\$150,000 per building per application. Secondly, Energy Efficiency Projects (EEP), which promotes existing building owners to carry out improvement works to upgrade the energy efficiency performance of building services installations including lighting, electrical, air-conditioning and lift and escalator installations, a limit of 50% of the total expenditure spent for the energy efficiency projects can be subsidized and the maximum of total government subsidy HK\$500,000 per building per application.

Lighting

The electricity consumed by lighting in residential sector in Hong Kong is 24% of the total consumption and that consumed in commercial sector is 15% (EMSD, 2010). Following air-conditioning, lighting is

the second highest electricity consuming installation in buildings.

a) Compact fluorescent lamp

Compact fluorescent lamp is one of the three products covered in the initial phase of the Mandatory Energy Efficiency Labelling Scheme which has been fully carried out since 9 November 2009. Under the Energy Efficiency (Labelling of Products) Ordinance (Cap. 598), only listed models with reference numbers and bear energy labels of the compact fluorescent lamps products can be supplied in Hong Kong.

b) T5 lighting

In the exploration of technologies suitable for local application, T5 fluorescent lamps had been tried and promoted. Three pilot T5 lighting projects have been completed in Arsenal House, Government Office in City Plaza and East Kai Tak Indoor Games Hall respectively. The T5 lighting installation was used to replacement the existing old lighting system. In the project at Arsenal House, 42% of power was reduced after the lighting retrofit. On the other hand, as a result of the T5 Lighting Retrofit at Government Office in City Plaza, there was an energy reduction of 32% in lighting (Energy Efficiency Office, 2011a). According to the result of the pilot project at East Kai Tak Indoor Games Hall, nearly 50% of power was eliminated through lighting efficiency (Wu, 2001). With the successful outcome among these pilot projects, it is worthy to promote the public and private sectors to use.

c) Light Emitting Diode (LED)

Another energy efficient technology which has been tested and introduced is Light Emitting Diode (LED).

When LED is applied on exit signs, more than 80% energy can be saved when compared to traditional fluorescent light. For building facades decorative lighting, using LED lamps can save 70% of the energy compared with conventional lamps. Besides, LED traffic light is used to replace conventional traffic light because of the energy saving by LED is over 70% (Energy Efficiency Office, 2011b). Apart from high energy efficiency, the life expectancy of LED is 50000 hours which is far longer than any other traditional lighting. Thus extensive promotion on the usage of LED should be enhanced.

Air-conditioning

Air-conditioning systems in Hong Kong currently consume about one-third of the total electricity consumption in Hong Kong (EMSD, 2010). With increasing population and development, the use of air conditioning will likely grow. Currently, the majority of the air-conditioning systems used in Hong Kong are air-cooled air-conditioning systems (AACS) which has fair energy efficiency compared to more advanced systems described below.

a) Water-cooled air-conditioning systems

When compared with AACS, Water-cooled air-conditioning systems (WACS) are more energy efficient. According to EMSD, 14% to 35% of energy can be saved from the use of various types of the water-cooled air conditioning system (EMSD, 2003). The conversion of AACS to WACS is expected to result in electricity saving and is currently promoted and studied by the Hong Kong Government.

b) Government Studies and Scheme

There are three direction for Water-Cooled Air-Conditioning Systems Schemes undertaken by Hong Kong

Government, which are the Fresh Water Cooling Tower Scheme, Central Seawater Scheme, and District Cooling Scheme. Implementation studies were carried out for South East Kowloon Development (SEKD) and Wanchai and Causeway Bay (WCCB) districts, which represent two different scenarios of the newly developed district and an existing developed district respectively.

c) District Cooling System (DCS)

DCS can be regarded as a mega-scaled centralized air-conditioning system, providing cooling services to multiple buildings through underground chilled water supply pipes. Energy saving of around 35% can be obtained by DCS when compared with conventional air-cooled systems (EMSD, 2004). With economy of scale, it is possible that it can be economical and provide significant energy savings.

3.2 US Situations

Policy Instrument

U.S. Green Building Council (USGBC) has developed a framework know as Leadership in Energy and Environmental Design (LEED) which is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across energy savings, water efficiency, CO2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts (U.S. Green Building Council, 2010). LEED is applicable to all building types – commercial as well as residential.

Water Cooling, Lighting and Heat Pumps

Water cooling has been one of the technologies supported by US policies. Department of Energy (DOE) estimated that if 6°C water is received through a 0.3 meter diameter pipe which delivering 0.08 cubic meters of water per second, it could provide more than enough air-conditioning for a large building (United States Department of Energy, 1989).

The State of Hawaii performed an analysis of the technical and economic feasibility of using deep cold seawater for cooling in Hawaii. Supplied with 7.4°C seawater, the total electrical energy required by a Seawater District Cooling (SDC) system is about 10%, or less, of what is needed for the conventional A/C system. In the Hawaii Kakaako case studies, it saved 92.5% of the energy compared to Conventional Cooling System. The costs associated with a seawater district cooling system is mainly related to the initial capital expenditure on pumps and pipelines needed to transport the deep seawater to end users. Average (State of Hawaii, 2002). Another example is the Makai's study in West Beach, Oahu where a new emerging resort allows Sea Water air condition system to be implemented (Makai Ocean Engineering, 2010). It was estimated lifetime savings can be as high as 50%. Heat pumps in US will also be able to get a tax credit amount of US\$300 for each household installed (Energy Star, 2011). Different approved rebate programme are provided in each state for different appliances. Like in the State of Tennessee, all residents can claim rebate on ENERGY STAR qualified appliances purchased from Tennessee retailers and licensed heating contractors. Rebates will be paid on a first come, first serve basis with the total program funding of \$5,660,000. When the incentive funds are exhausted, no further rebates will be paid. (Tennessee Department of Economic & Community, 2011)

The US Congress passed the Energy Independence and Security Act in December 2007 and mandates the phasing out of the traditional light bulb. A federal ban on the 100-watt incandescent light bulb will take effect on December 31, 2011. Two years after that, the 60-watt and 40-watt versions will disappear from stores.

EU Situations

Policy

The GreenBuilding Program (GBP) is a voluntary program that started in 2004. It is meant to enhance the realization of cost-effective energy efficiency potentials by creating awareness and providing information support and public recognition to companies and residents (Green Building Programme, 2010). According to the Green Paper on Energy Efficiency, the building sector accounts for more than 40% of the final energy demand in Europe (EU, 2005). At the same time, improved heating and cooling of buildings constitutes one of the largest potentials for energy savings.

Lighting

In EU countries, Compact Fluorescent Lamp (CFL) markets are mature with decreasing prices, such as in Scandinavian countries, direct subsidy programs become less important in facilitating the use of CFL's. But in immature markets, such as in many non-OECD countries, properly designed subsidy programs can be an important and cost effective tool for moving markets to make better use of CFL. The UK government and the gas and electric utility industry established UK Energy Saving Trust (EST) conducted several lighting programs between 1994 and 1997, including subsidies through a manufacturer rebate

mechanism and give-away programs. Rebates were offered to consumers in the form of a price reduction at the point of retail, including a matching subsidy by the manufacturer. In the program, 800,000 households received a 20-W CFL to replace 100-W incandescent GLS lamps. Analysis showed that the give-away programs generated up to 20% direct lamp sale after the most recent 1996-97 program. Studies of the UK rebate programs also estimate indirect benefits at about 10% of the total program sales of 3 million CFLs. The awareness of CFLs has gone up from approximately 50% in 1993 to more than 75% in 1997. Average UK CFL prices have dropped from about US\$24 in 1993 to about US\$16 in 1997 (Heywood and Rowe, 1997a and 1997b).

The Poland subsidy program was unique in the way subsidies were channelled through the private-sector. The intention was to use manufacturers' knowledge of the marketplace to maximize CFL sales per dollar of available subsidy. In this case, a large retail price reduction (about US\$6) was possible with a smaller program subsidy (about US\$2) because of manufacturer subsidy contributions and the multiplier effects of VAT tax and retail mark-ups. During 1995-1997 in two separate promotions, consumers bought 1.2 million CFLs through the project (half within the first month of each promotion), with over 40 different models represented. This program was easy to manage, was considered cost-efficient, and allowed use of available distribution channels. Five manufacturers participated in the subsidy program and only two manufacturers (General Electric and Philips Lighting) dominated the program. Both were seriously pursuing the Polish market and Phillips was the most aggressive player in the Polish market before the project began. (Martinot & Borg, 1998)

Japan Situations

Policy

The Japanese government is dedicated in promoting energy efficiency as the energy consumption in both residential and commercial sectors in on the rise. The government has set an ambitious target of improving energy efficiency by at least 30% by 2030. Under the Energy Conservation Law, manufacturers of various machines or appliances including air conditioners, television, lighting apparatus, PCs, cars and stoves, are required to achieve standard energy conservation target values (ANRE, 2008). Other programmes such as energy conservation labelling system, heat insulation of housing and buildings and building energy management system are also promoted.

Incentive and promotion

The Energy Conservation Center Japan has conducted an energy audit program for factories or buildings free of charge. After assessing the designated building, the program helps to provide professional advice in remediating potential areas for energy saving. A total number of 2,306 buildings benefited from the audit program from 1998 to 2007 (The Energy Conservation Center Japan, 2011).

In addition to the provision of policy drive and incentive, education is also an integral part in promoting energy conservation. For example, the government provides online database on industrial energy-saving equipment which allows the public to make informed decision in purchase. Guidebook on energy conservation for buildings were compiled, giving practical recommendations on energy saving issues such as how to prevent the mixing loss of cold air and hot air (The Energy Conservation Center Japan,

2010).

Singapore Situations

Policy

The National Energy Efficiency Committee (NEEC) was established in 2001 for the implementation of programmes to promote energy efficiency in various sectors, including industries, homes, commercial buildings and vehicles. The NEEC was later renamed as the National Climate Change Committee (NCCC) in 2006 to reflect its strengthened role in combating climate change (National Environment Agency, 2011). In Singapore, energy labelling for air-conditioners, refrigerators and clothes dryers are mandatory. Besides, some categories of motor vehicles are also included under the Mandatory Fuel Economy Labelling.

Buildings, another major source of energy consumption are also covered in labelling schemes on a voluntary basis. Office, hotel and retail mall sectors are eligible in the Energy Smart Building Labelling Programme, though it which will be discontinued in 2011 (Energy Efficient Singapore, 2010a). In developing partnership, the Building and Construction Authority of Singapore (BCA) collaborates with the construction industry by formulating the BCA Green Mark Scheme in working towards environment-friendly buildings. The Scheme provides benchmarking which incorporates internationally recognized best practices in environmental design and performance for different types of buildings (Building and Construction Authority, 2010).

Incentive and promotion

The incentive schemes for promoting efficient use of energy are comprehensive in Singapore. The one-year accelerated depreciation allowance is provided for the adoption of energy efficient equipment and technology in business (National Climate Change Committee, 2007a). Under the Energy Efficiency Improvement Assistance Scheme, up to 50% funding is available for energy appraisal in manufacturing and building sectors (Energy Efficient Singapore, 2010b). The funding for industries is even higher, up to 80% funding for consultancy fees in integrating energy and resource efficiency improvements into manufacturing development plans (Energy Efficient Singapore, 2010c). To raise public awareness on energy saving, energy saving tips and energy labelling scheme information are made available in the website, allowing consumers to make informed decisions (National Climate Change Committee, 2007b).

Taiwan Situations

Policy

Announced in the Framework of Taiwan's Sustainable Energy Policy in 2008, Taiwan aims to improve energy efficiency by more than 2 % each year. With policy and technological measures, energy consumption is expected to decrease by 20% and 50% respectively in 2015 and 2025 compared with 2005 level. Core policies include better urban planning, promoting green architecture through energy conserving design of building facades and air-conditioning system, increasing appliance efficiency standards by 10% to 70% in 2011 and adopting high efficiency lighting (Ministry of Economic Affairs, 2008).

Incentive and promotion

Discount on energy bills would be given to households and schools whose energy consumption is equal to or less than the previous, serving an incentive to drive energy conservation in the community. For business, tax incentive and loans are provided for the purchase of energy efficiency equipment or technology. (Ministry of Economic Affairs, 2010)

The educational materials in promoting energy saving initiated by the government are overwhelming, covering various sectors including residential, commercial, industrial transportation and educational training (EnergyPark, 2009). The experience sharing of energy conservation is also encouraged by compiling the successful cases in different sectors (Taiwan Green Productivity Fund, 2010).

Identifying Best Practices in Overseas Countries

Based on our literature review and comparison of various applications of energy saving equipment and measures in green building around the world, we identified the following best practices and successful cases which will be effective in Hong Kong:

Heating, Ventilation & Air-conditioning – Water_Cooling Tower Scheme; Central Sea Water Scheme;

District Cooling Scheme; Building Insulation (Wall/Roof); Heat Pump in Air-conditioning

Lighting - Compact Fluorescent Lamp (CFL); Light Emitting Diode (LED); T5 Lamp

Other Policy Instruments - Education; Promotion; Government Enhancement; Building Energy Efficiency

Ordinance; Energy Audit; Electricity Bill Rebate; Tax Incentive; Building Labelling; Equipment Energy

Public Survey and Analysis

An online survey has been conducted to gauge public acceptance in Hong Kong of some of the potential energy efficiency policies. All respondents are Hong Kong citizens. In our questionnaire, we have asked the respondent to give a score from one to five for each of the measures proposed, which we will then obtain an average score for the relevant policies. In total, there were 113 respondents to our questionnaire and the questions and result are presented in table 1.

Potential Energy Efficiency Policies	Average score	Standard Deviation (SD)
Only allow Compact Fluorescent light bulbs with energy label to be sold in the market	3.87	0.80
Ban Incandescent light bulb	3.03	0.99
LED light bulb subsidy scheme	3.88	0.91
T5 Fluorescent Tubes subsidy scheme	3.63	0.83
Promote freshwater cooling tower scheme, promote and encourage connection	3.42	0.89
Seawater cooling tower scheme, promote and encourage connection	3.45	0.92
District cooling scheme in all districts	3.47	0.85
Heat pump installation loan scheme	3.51	0.91
Double glazing loan scheme	3.68	0.95

Improved building wall insulation loan scheme	3.60	0.90
Legislate for minimum heat insulation efficiency for buildings	3.67	1.00
Include energy efficiency in general education syllabus	3.96	1.03
Promotion by advertisement	3.79	0.88
Promotion by display boards in malls and markets	3.28	1.07
Government would take the lead by overhauling government building with energy efficiency measures	3.90	0.93
Government to enforce energy efficient procurement and guidelines	3.84	0.92
Apply building efficiency code to all existing buildings	3.43	0.97
Government subsidy for 1/2 the cost of an energy audit	3.72	0.96
Electricity bill rebate for energy savings	4.28	0.99
Accelerated depreciation for energy efficient equipment	4.04	0.89
energy efficient labeling scheme for commercial buildings	3.77	0.88
Mandatory energy efficiency labeling for most electrical appliances	3.96	0.91

Table 1 – Questions and Data Analysis for Online Survey on Potential Energy Efficiency Policies

The survey result shows that there is a general support towards promotion of energy efficiency as a whole.

It is however worth noting that the public is more supportive towards measures that either have an immediate financial benefit (e.g. bill rebate; accelerated depreciation) or simply easy to understand (government overhaul, mandatory labelling scheme). Policies that have a high impact factor like improving cooling efficiencies (e.g. district cooling) and banning of incandescent light bulbs has a poorer

public acceptance. This could be explained by a poor level of understanding of the benefits of these policies, indeed we have received feedback from the respondents that they are unfamiliar with some policies or some are too new or sound too technical for them to understand. Therefore, in order to further any attempt, we believe that education has a crucial role to play in order to better inform our citizens, thereby enabling the public to make better priority of preferences.

Due to limited resources, we were only able to conduct online survey and therefore the response results might not properly reflect the view of more influential stakeholder in this domain, for example an office building manager. It is recommended that further research could be conducted in this area, as well as increasing the sample size.

Discussion and Recommendation

Institutional

We noticed that one of the potential reasons for the slow progress in the energy efficiency promotion in Hong Kong might be the institutional structure of Hong Kong Government. We found that most of the overseas countries established dedicated government agency, such as the Department of Energy in the US and National Climate Change Committee in Singapore, which are fully in-charge of energy and carbon issues. In Hong Kong by comparison, responsibility is dispersed between the Environmental Bureau, Environmental Protection Department and the Electrical & Mechanical Services Department, each of which has other policy areas to deal with as well. We recommend that the establish of an Energy Bureau, which will be at a higher level to take charge and control all related policies and regulations related to

energy consumption, carbon emission and climate change.

Financial incentives

Commodity price is one of the determining factors in influencing consumer's behaviour of choosing household energy-saving products, which tend to be more expensive when compared to non-energy saving products. Providing subsidy for the general public on the purchase of energy-saving products will enhance the widespread use of such items as mentioned in the overseas studies. Further tax incentives should also be provided for commercial sectors with purchase or direct investment in energy conservation equipment. Our survey indicates that such policies would be readily accepted by the public as well.

Education and promotion

Education on the importance of energy efficiency and conservation, as well as practical tips on energy saving will be vital in raising the awareness of the general public and allowing them to make informed decisions. The Hong Kong Government has the energy efficiency website EENet (EMSD, 2007a) which is rather technical and difficult for common citizens to understand. The Hong Kong Government should consider setting up a comprehensive website similar to Taiwan (EnergyPark 2009), which is expressed in more layman terms and can serve as a platform for delivering all policies and programmes in connection with energy conservation. We recommend that households with electricity consumption 30% less than that of previous year should be rebated with a 30% on energy bill. In addition, an Energy Bill Rebate Competition should be rolled out territory wide to provoke interest in the subject and to render participation of all Hong Kong households in energy efficiency and conservation.

Lighting

We reckon that there was an unsuccessful rebate policy attempt in 2010, which failed mainly due to other political reason. Rather than providing rebate, the government could revitalise lighting efficiency through banning of traditional incandescent light bulb, which will indirectly widen the market of compact fluorescent lamp, T5 lighting and Light Emitting Diode (LED). From our survey result, we recognise that there is a lack of public awareness of the environmental unfriendliness of incandescent light bulbs, stronger promotion and education should be provided to heighten public awareness and understanding of energy efficiency issues. From overseas experience, it is expected when a mature market is formed, the high price of the energy-efficient lighting products will decrease.

Air conditioning

From overseas experience and local studies, Water Cooled Air-Conditioning System is much more energy-efficient than air-cooled air-conditioning systems which is currently the dominant design of the air-conditioning systems used in Hong Kong. Apart from the Kai Tak DCS Project, the Hong Kong Government should take the initiative to promote the use of water cooled technologies in dense business building such as Central and Wanchai and also provide low-interest rate loan to subsidize the high initial cost of advance cooling systems. Hong Kong Government could provide rebates for installation of water cooled system based on first come, first serve approach, where no further rebates will be paid after the total program funding has been exhausted as in US. From our survey result, the public is unaware of water cooling technologies and district cooling systems, not to mention the energy efficient benefits of

such systems. The government should aggressively build up community knowledge of the benefits of such technologies in order to gather public support in promoting these high gain areas.

In Japan, recommendations on heat insulation of housing and buildings are promoted. In Hong Kong, information is lacking on this regard. When a building is well insulated, it is easier to keep the space with a uniform temperature and as a result a lower demand of the output of air-conditioner. An uninsulated wall could account up to a third of the heat lost (Energy Saving Trust, 2011), Hong Kong Government should be more aware of the importance of heat insulation of building and promote heat insulation technology to the public.

Reference

1. ANRE. *Promotion of Energy Conservation*. Agency for Natural Resources and Energy. Government of Japan. (2008). Retrieved 18 January 2011 from http://www.enecho.meti.go.jp/english/toprunner/11.12english2008_pdf.pdf
2. Building and Construction Authority. *BCA Green Mark Scheme*. (2010). Retrieved 1 February, 2011 from http://www.bca.gov.sg/GreenMark/green_mark_buildings.html
3. Elliott, D., Supporting renewables: Feed in tariffs and quota/trading systems., *Sustainable energy: opportunities and limitations* pp174-189. Palgrave Macmillan. New York (2007).
4. EMSD. *Territory-Wide Implementation Study for Water-cooled Air Conditioning Systems in Hong Kong*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2003). Retrieved January 21, 2011 from http://www.emsd.gov.hk/emsd/eng/pee/wacs_pub.shtml
5. EMSD. *District Cooling System*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2004). Retrieved 31 January, 2011 from http://www.energyland.emsd.gov.hk/eng/building/cool_hk.htm
6. EMSD. *Energy Efficient Technologies – HK EE Net*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2007a). Retrieved 21 January 2011 from <http://ee.emsd.gov.hk/eindex.html>
7. EMSD. *Guidelines on Energy Audit*, Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2007b). Retrieved January 31, 2011

http://www.emsd.gov.hk/emsd/e_download/pee/Guidelines_on_Energy_Audit_2007.pdf

8. EMSD. *Hong Kong Energy End-use Data*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2010) Retrieved January 21, 2011 from http://www.emsd.gov.hk/emsd/eng/pee/edata_1.shtml
9. EMSD. *Voluntary Energy Efficiency Labelling Scheme*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2011a). Retrieved January 31, 2011 from http://www.emsd.gov.hk/emsd/eng/pee/eels_vlntry.shtml
10. EMSD. *Mandatory Implementation of Building Energy Code (BEC)*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2011b) Retrieved January 31, 2011 from <http://www.emsd.gov.hk/emsd/eng/pee/mibec.shtml> (accessed January 30, 2011)
11. EMSD. *HK Energy Efficiency Registration Scheme for Buildings*, Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2011c). Retrieved January 21, 2011 from <http://www.emsd.gov.hk/emsd/eng/pee/eersb.shtml>
12. Energy Efficiency Office. *A Decade of Energy Efficiency and Conservation*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2004)
13. Energy Efficiency Office. *Guidelines on T5 fluorescent lamps*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2011a). Retrieved January 23, 2011 from http://www.emsd.gov.hk/emsd/e_download/pee/t5guide.pdf
14. Energy Efficiency Office. *LED: a kind of Unconventional Lamp*. Electrical and Mechanical Services

- Department. The Government of the HKSAR. Hong Kong (2011b). Retrieved 21 January 2011 from http://www.emsd.gov.hk/emsd/e_download/pee/LED1.pdf
15. Energy Efficient Singapore. *Energy Smart Building Labelling Programme*. Government of Singapore. Singapore (2010a). Retrieved 27 January 2011 from <http://www.e2singapore.gov.sg/buildings/energysmart-building-label.html>
 16. Energy Efficient Singapore. *Energy Efficiency Improvement Assistance Scheme*. Government of Singapore. Singapore (2010b). Retrieved 27 January 2011 from <http://www.e2singapore.gov.sg/ease.html>
 17. Energy Efficient Singapore. *Design for Efficiency Scheme*. Government of Singapore. Singapore (2010c). Retrieved 27 January 2011 from <http://www.e2singapore.gov.sg/design-for-efficiency.html>
 18. Energy Saving Trust. *Home insulation & glazing*. UK (2011). Retrieved 27 January 2011 from <http://www.energysavingtrust.org.uk/Home-improvements-and-products/Home-insulation-glazing>
 19. Energy Star. *2011 Federal Tax Credits for Consumer Energy Efficiency*. United States (2011). Retrieved 25 January 2011 from http://www.energystar.gov/index.cfm?c=tax_credits.tx_index
 20. EnergyPark. *EnergyPark Homepage*. Taiwan (2009) Retrieved 25 January 2011 from <http://www.energypark.org.tw/index.asp> (in Chinese)
 21. Environment and Conservation Fund. *Buildings Energy Efficiency Funding Schemes*. The Government of the HKSAR. Hong Kong (2011) Retrieved 31 January 2011 from <http://www.building-energy-funds.gov.hk/en/index.html> (accessed January 31, 2011)

22. EPD. *Climate Change*, Environmental Protection Department. The Government of the HKSAR. Hong Kong (2010). Retrieved 31 January 2011 from http://www.epd.gov.hk/epd/english/climate_change/bldg.html
23. EU. Commission Green Paper, "Energy Efficiency - or Doing More With Less", European Union Commission. European Union (2005). Retrieved 11 January 2011 from http://europa.eu/legislation_summaries/energy/energy_efficiency/l27061_en.htm
24. GreenBuilding Programme. *The GreenBuilding Programme*. European Union (2011). Retrieved 11 January 2011 from <http://www.eu-greenbuilding.org/index.php?id=163>
25. Heywood A., Rowe A. *Low energy lighting for low-income households*. Right Light 4 Proceedings of the 4th European Conference on Energy-Efficient Lighting Association of Danish Electric Utilities and the International Association for Energy Efficient Lighting. Stockholm (1997a).
26. Heywood, A., Rowe, A. *Changing attitudes on lighting energy efficiency in the UK: A report on progress from the Energy Saving Trust*. Proceedings of the 4th European Conference on Energy-Efficient Lighting Association of Danish Electric Utilities and the International Association for Energy Efficient Lighting. Stockholm (1997b).
27. HKSAR. *Combating Climate Change*. 2010-11 Policy Address, The Government of HKSAR. Hong Kong (2010). Retrieved 11 January 2011 from <http://www.policyaddress.gov.hk/10-11/eng/p111.html>
28. International Energy Agency. *Energy Efficiency Governance: Handbook*. (2010) Retrieved 11 January 2011 from <http://www.iea.org/papers/2010/eeg.pdf>

29. Makai Ocean Engineering. *Cold Seawater Air Conditioning*. (2010) Retrieved 8 January 2011
from <http://www.makai.com/p-swac.htm>
30. Martinot E., Borg N., Energy-efficient lighting programs: experience and lessons from eight countries *Energy Policy*. Volume 26. pp1071-1081. (1998)
31. Ministry of Economic Affairs. *Framework of Taiwan's Sustainable Energy Policy*. Taiwan (2008).
Retrieved 8 January
2011 http://www.moea.gov.tw/Mns/english/content/ContentLink.aspx?menu_id=196&sub_menu_id=3886
32. Ministry of Economic Affairs. *Energy Saving*. (2010). Retrieved 8 January 2011
http://www.moeaboe.gov.tw/opengovinfo/Laws/saveenergy/LSaveMain.aspx?PageId=l_save_list (in Chinese)
33. National Climate Change Committee. *Incentive Scheme*. Government of Singapore. Singapore (2007a). Retrieved 8 January 2011 from <http://www.nccc.gov.sg/incentive/home.shtm>
34. National Climate Change Committee. *Energy Saving Guide*. Government of Singapore. Singapore (2007b) Retrieved 18 January 2011 from http://www.nccc.gov.sg/Households/es_guide.shtm
35. National Environment Agency. *Energy Conservation: Background*. Government of Singapore. Singapore (2011). Retrieved 18 January 2011 from
http://app.nea.gov.sg/cms/htdocs/category_sub.asp?cid=71
36. State of Hawaii. *Sea Water District Cooling Feasibility Analysis for the State of Hawaii*. Department

- of Business, Economic Development & Tourism Energy, Resources, and Technology Division, State of Hawaii, United States (2002).
37. Taiwan Green Productivity Fund. *Successful cases*. Taiwan (2010). Retrieved 1 January 2011 from <http://www.ecct.org.tw/success/NEW/index.htm> (in Chinese)
 38. Tennessee Department of Economic & Community Development, *Tennessee Energy Efficiency Appliance Rebate Program*. United States (2011). Retrieved 25 January 2011 from <http://teearp.efi.org/>
 39. The Energy Conservation Center Japan. *Guidebook on Energy Conservation for Buildings*. Japan (2010). Retrieved from http://www.asiaeec-col.eccj.or.jp/brochure/pdf/guidebook_buildings.pdf
 40. The Energy Conservation Center Japan. *Energy Audit Program*. Japan (2011). Retrieved 21 January 2011 from <http://www.asiaeec-col.eccj.or.jp/sector/com-resident/eneauditprog.pdf>
 41. United States Department of Energy, Comprehensive Ocean Thermal Technology Applications and Market Development (TAMD) Plan. *Sixth Annual Update to Congress in response to PL 96-310*. United States (1989).
 42. U.S. Green Building Council. *Intro – What Leeds Measures*. United States (2010). Retrieved 3 January 2011 from <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1989>
 43. Wu K.T., *Report of high-output T5 lighting project at East Kai Tak Indoor Games Hall*. Electrical and Mechanical Services Department. The Government of the HKSAR. Hong Kong (2001). Retrieved 21 January 2011 from http://www.emsd.gov.hk/emsd/e_download/pee/t5_ektigh.doc