Lighting for more with less @ BEC

Paper for CIE (Hong Kong) 6th International Lighting Symposium 2015

"Lighting Development and Application – The Next Direction", 30 October 2015

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ABSTRACT:

About 90% of the total electricity consumption in Hong Kong is from buildings. Hence, greenhouse gas emissions can be effectively reduced through enhancement of the energy efficiency of buildings. The Buildings Energy Efficiency Ordinance, Cap 610 (BEEO) came into full operation in 2012. It requires the compliance with the Building Energy Code (BEC) in respect of the design of building services installations in newly constructed buildings and for major retrofitting works in existing buildings.

Lighting installation is amongst the central building services installations regulated under the BEC. In the BEC 2012 edition, the lighting power density for various types of space is the major controlling parameter to ensure the efficiency of lighting installation. To keep abreast of the technical and legislative advancements, review of the BEC is now in progress for completion by end 2015. This paper provides an overview on the prescribed requirements of the BEEO as well as an insight into the tightened requirement of lighting installation in the BEC 2015 edition including the new perspectives on automatic lighting control and the use of natural light for creating an energy efficient and amicable built environment.

I. INTRODUCTION

Hong Kong is famous for its city scrappers and splendid night lights. Not surprisingly, our buildings consume about 90% of the city's electricity. In 2012, Hong Kong consumed 155,079 TJ (about 43,078 million kWh) of electricity in total. Improving energy efficiency for buildings will certainly help to reduce the greenhouse gas emissions and alleviate the climate change induced by global warming.

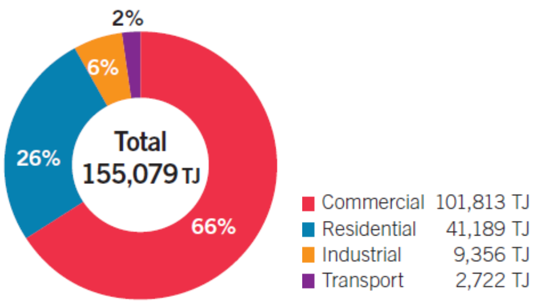

Figure 1 - Electricity consumption by sector, 2012

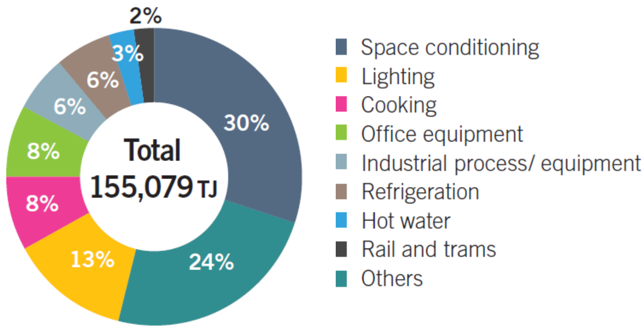

Figure 2 – End-uses of electricity in Hong Kong, 2012

The Buildings Energy Efficiency Ordinance (BEEO) and its Codes give a legislative foundation to continuously save energy with the target to minimize energy use in buildings. The BEEO establishes both the energy efficiency standards of a building for its design and the means to evaluate its energy efficiency performance in operation stage. For building design, the BEC governs the design standards in respect of energy efficiency of building services installations, whereas for building operation, the Energy Audit Code (EAC) sets out the technical guidance and details in conducting energy audit of its central building services installations (CBSI, which refers to the building services installation not solely serving an individual unit of the building).

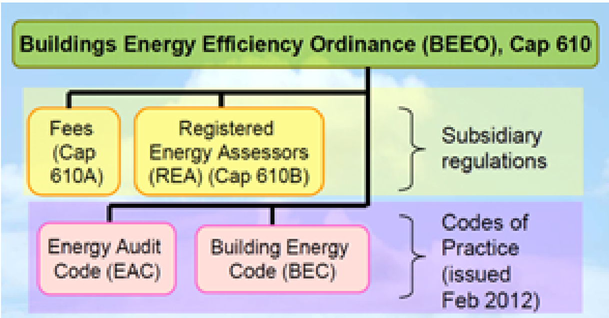

Figure 3 : BEEO compliance hierachy

The BEEO prescribes the responsibilities of the developer, owner or responsible person of a building or a unit of the building, and the Registered Energy Assessor (REA), with requirements of submission and certification to demonstrate the compliance at different stages of the building cycle, from design to occupation approval and subsequently during normal course of operation.

Since the enforcement, the relevant statutory submissions on stage one and two declaration, Certificate of Compliance Registration (COCR) for new buildings, and Form of Compliance (FOC) for major retrofitting works in new and existing buildings are in good progress. Up to August 2015, over 750 nos. of stage one declaration and 3,000 nos. of FOC have been received whilst around 60 nos. of COCR have been issued.

Pursuant to the BEEO, for the first batch of buildings, over 99% of the buildings complied with the energy audit requirements. For the second batch of buildings, energy audit reports have already been submitted for over 70% of the buildings. Meanwhile, outreaching programme has been conducted to third batch of buildings to remind them to carry out the energy audit before the specified date

II. NEW LIGHT TO ILLUMINATE THE WORLD

Lighting is the third largest type of electricity end-use in Hong Kong. With almost two decades of experience in promoting energy efficiency and conservation in Hong Kong, Energy Efficiency Office (EEO) of EMSD has successfully promoted the application of a number of advanced energy efficient lighting technologies including electronic ballast, compact fluorescent lamp, T5 fluorescent lamp, etc.

We have launched a charter scheme with suppliers and retailers to commit to stop selling the energy inefficient incandescent light bulbs (ILBs) by the end of 2013, while stepping up our publicity efforts to educate the public and major lamp users on the benefits of using more energy efficient lamps such as compact fluorescent lamps (CFL).

The rapid development of LED technology has made significant change on the lighting equipment and design. On 7 October 2014, the Royal Swedish Academy of Science had decided to award the Nobel Prize in Physics for 2014 to Isamu Akasaki, Hiroshi Amano and Shuji Nakamura for the invention of efficient blue light-emitting diodes (LED) which has enabled bright and energy-saving white light sources.

The LPD requirement for office and corridor are 23W/m^2 and 15W/m^2 respectively in the Code of Practice for Energy Efficiency of Lighting Installation 2005 Edition.

With the application of the new technology and the enhancement on efficacy of the lighting luminaire (which include the use of electronic ballast and higher reflectance reflector), the LPD requirement can be further reduced to 15W/m^2 for office and 10 W/m^2 for corridor in the Code of Practice for Energy Efficiency of Building Services Installation 2012.

In early 2014, addendum to BEC 2012 had been issued to tighten some of the lighting standards (e.g. 13W/m^2 for office and 8 W/m^2 for corridor) and ensure their comparability with other relevant international standards.

III. BEC REVIEW

The BEC and EAC will be reviewed at a 3-year interval since the initial edition issued in 2012 to further tighten the energy efficiency standards.

In each review, reference will be made to the latest worldwide technological development as well as the updated international standards. Undoubtedly, public aspirations will also be one of our key concerns. In order to gather the ideas for different stakeholders, different working groups and a taskforce with the participation of professions and practitioners from the industry were established.

A comprehensive review of the BEC and EAC is now under way and it is anticipated that the 2015 edition would be ready for gazette by end 2015. The latest review of the BEC on the lighting installation include the followings:-

1) Tighten exemption criterion on the lighting power density (LPD) requirement
2) Add and further tighten LPD requirement for certain types of spaces.
3) Extend the requirement of lighting control point to cover all spaces.
4) New requirement on the provision of automatic lighting control to dim down or shut off the lighting automatically.
5) New requirement on the provision of daylight responsive control to dim down or shut off the lighting automatically for space with fenestrations or overhead skylight.

Apart from limiting the lighting power density, with the adoption of the proper lighting control strategies in the design, the total energy consumption of the lighting system can be further reduced by turn OFF or dimming down the unnecessary lights.

Figure 4 – Unrequired lighting for corridor without occupancy

There are 3 major method for automatic control of lighting as delineated in the BEC 2015 edition, which are, daylight responsive, occupancy responsive or timer responsive. By the use of daylight sensor, occupant sensor and timer control, the lighting can be switched off automatically for uninhabited place and/or when the space is naturally lit.

Each type of control have different characteristic. It shall be chosen according to the site constraint, usage of area and the occupancy pattern.

1) Daylight Sensor

Daylight sensor contains photocell to measure availability of ambient light in the space. The sensor can control the on/off switching of various luminaires installed if daylight is sufficient to light up the interior to the required lighting level. It can also operate a continuous dimming system in order to top-up with artificial lighting to the desired illuminance value.

With due consideration of the building orientation, form, disposition, fenestration, skylight and shading device, the integration of daylighting in the lighting design not only can enhance energy performance of buildings but also achieve a psychologically more peasant and potentially more comfortable interiors.

Artificial lighting design often puts emphasis on illuminance level and uniformity. There is evidence that a lower luminance is required from daylighting than artificial lighting. Also, people prefer the continual variation of brightness in a daylit room. Although the reason for this is not certain yet, it is possible that both physiological and psychological processes are involved. It is known, for instance, that performance is better when the colour rendering quality of the source is improved; the flow of light from a side window is soft but directional, giving good three dimensional modelling; it is also true that people prefer daylit rooms, so improved motivation might be a factor.

Daylight is readily available for areas near windows, glass walls and skylights. Where it is technically feasible, fixed installations which divert direct sunlight into the occupied space and enhance the effectiveness on use of daylight can also be applied. Artificial lighting can be turned off or dimmed to a level for topping-up the available natural light in order to achieve the required lighting level through monitor and control by daylight sensors.

The following examples demonstrated the application of daylight by some trial projects in our EMSD Headquarters Building:

a) Sunpipes

Sunpipes are installed on the roof. Sunlight is captured through the roof top dome of each sunpipe. It then travels down the sunpipe's highly reflective tube to illuminate the corridor. The size of each aluminum light tube is about 250mm diameter and 2,800mm long. In addition, the ray bender inside the dome helps capture and reflect light that is not directly above the tube. The light captured is then channeled down through a highly reflective shaft and diffused indoor. On a sunny day, the brightness of a sunpipe is equivalent to the brightness of about 4 nos. of 11W compact fluorescent lamps.

Figure 5 : Corridor properly lit up by Sunpipes

b) Light Shelve

Light shelve is installed under one of the existing window in the lift lobby. The highly reflective curved surface of the light shelve captures and re-directs the sunlight for penetration into the inner area. Artificial lighting inside the lobby area are switched off in most of office hours except during cloudy or rainy days.

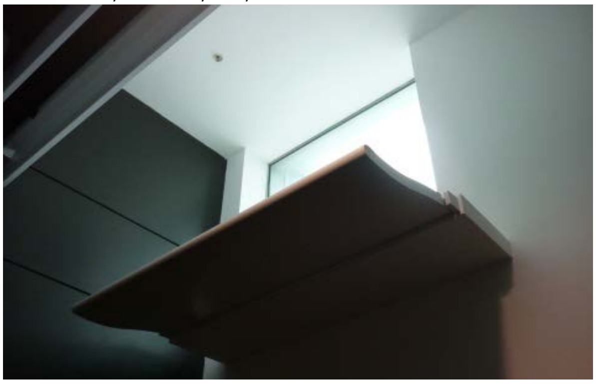

Figure 6 : Light Shelve installed under fenestration

2) Occupancy Sensor

Lighting is only required when someone is present in the indoor space. Unfortunately, lamps are remained "ON" when the occupants are temporarily absent (e.g. to attend a meeting or during lunch time) or even already left their workplace. To minimize such energy wastage, the presence of adequate lighting control points with proper housekeeping is considered crucial and the best way is the adoption of automatic lighting control function using occupancy sensor (or motion detector) as the triggering device. Apart from on/off control on the lighting system, owners may consider dimming function so that a minimum lighting level can be retained to avoid causing nuisance to the users due to the sudden on/off action but also maintaining some light for security.

There are different types of occupancy sensor by using different detecting method and two commonly used are listed below:-

a) Passive infrared (PIR) sensors

PIR sensors detect and respond to the movement of a warm body across their field of view. Their normal effective range is about 10m. They are relatively inexpensive. Since they measure infrared light radiating from objects, they are strictly line-of-sight devices.

b) Ultrasonic (US) detectors
US detector can be operate up to 50m. They emit inaudible sound patterns at frequencies that are above human sensitivity, typically 25, 30 and 40 kHz. They detect occupant by measuring the Doppler shift of radiation reflected from a moving body. They are more sensitive than PIR sensors and can detect very minor motion. However, they are also more susceptible to false triggers from any movement in the space, which include breezes from open windows and air movement by HVAC system.

In addition, attention shall be taken on the interval setting to avoid frequent switching. Manual ON shall be designed with the occupant sensor used to switch the light off when the occupant leave for a set time. Normally, the light shall be switched off from 10 to 15 minutes after no occupancy detected.

3) Timer switch
Timer switch can be used for space with fixed occupancy pattern, such as offices, schools and libraries. A simple timer switch can be installed to switch on lights just before the working hour and switch off the lighting after operation hours. It is also a good practice to switch off the office lighting during the lunch break.

Some advance type of timer switches allow scheduling controls. The timer switch is capable to ON/OFF the system with different time setting for seven different day times per week. If the lighting system is integrated with the Building Management System (BMS), it can allow to have more complicated scheduling, e.g. inclusion of holidays.

Some form of overriding can be provided for people working late, security reason or cleaning. An accessible manual override, or equivalent function can also be provided for local controls to switch on individual luminaires or small groups of luminaires back on as required after the business hours. However, as most people tend to switch on the light rather than switch off the light purposely, reset control shall also be considered to add-on the manual override to prevent the lights being left on all night.

IV. CONCLUSION

With the implementation of the BEEO that serves as the key driver for enhancing the energy efficiency of buildings, Hong Kong has taken the major step forward in addressing the impacts of climate change brought about by energy consumption in buildings. This mandatory approach reinforces the roothold of the minimum energy efficiency standards in the BEC and the minimum energy audit requirements in the EAC, and paves the way for further enhancement of the standards. EMSD will review and tighten the standards at suitable time intervals. The issue of the BEC 2015 edition will further trigger a new round of improvement in the pursuit of enhancing the energy efficiency of buildings.

V. ACKNOWLEDGEMENTS

Sincere thanks are extended to members (including CIE(HK)) of the Technical Taskforce on Mandatory Implementation of the BEC and its working group of lighting installation, in offering their expertise advice and support in the development of the BEC 2015 edition and its technical guidelines.

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