

# **Energy Audit for Commercial Buildings in Mandatory Implementation of Building Energy Codes**

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## **Abstract**

Reducing electricity consumption in buildings is important in addressing the growing concerns of global warming, local air quality and energy security. Energy audit is a proven effective measure for energy savings through identification of energy management opportunities for improvement in buildings. The Government has been implementing energy audits to government office buildings of major electricity consumption with an aim to reduce electricity consumption. For promotion of energy savings in buildings in private sector, the Government launched a 3-month public consultation to the mandatory implementation of the Building Energy Codes (BEC) in late 2007. The consultation ended in March 2008 and majority of the comments received were in support of the mandatory proposal.

Amongst the requirements in the proposed mandatory scheme, it is suggested that commercial buildings will be required to have an energy audit carried out once every ten years. The Electrical and Mechanical Services Department (EMSD) has established a Technical Task Force comprising representatives from professional bodies, electrical & mechanical contractors' associations, properties management companies and estate development associations, academes as well as other government works departments to compile the detailed energy audit requirements.

This paper outlines the energy audit procedures and provides some examples of energy saving opportunities in government office buildings through energy audits. The latest development of the proposal for mandatory implementation of energy audits for commercial buildings will also be briefly addressed in the Paper.

**Keywords :** energy audit, energy management opportunities, Building Energy Codes

## **1. Introduction**

An energy audit is a systematic review of the energy consuming installations in a building or premises to ensure that energy is being used sensibly and efficiently. An energy audit usually commences with the collection and analysis of all information that may affect the energy consumption of the building or premises, then follows with reviewing and analyzing the condition and performance of various building services installations and building management, with an aim at identifying areas of inefficiency and suggesting means for improvement.

Through implementation of the suggested improvement measures, building owners can get the immediate benefit for paying less for energy bills. On the other hand, lowering of energy consumption in buildings will lead to the chain effect that less fossil fuels will be burnt for electricity generation by the power supply companies and relatively less pollutants and green house gases will be introduced into the atmosphere, thus contributing to conserve the environment and to enhance sustainable development.

## **2. Energy Audit**

An effective means to improve energy efficiency and conservation in buildings is through implementation of the Energy Management Opportunities (EMO) identified in energy audits. EMO can be classified into three categories:-

- (i) Category I - This category of EMO involves housekeeping measures which are improvements with practically no cost investment and without any disruption to building operations, such as turning off air conditioning/lighting when not in use or changing air conditioning set-points.
- (ii) Category II - This category of EMO involves changes in operation measures with low cost investment, such as improvement in lighting switching arrangement or addition of timer control.
- (iii) Category III - This category of EMO involves relatively higher capital cost investment to attain efficient use of energy, such as addition of variable speed drives for pumps/fans or replacement of chillers.

In many cases, the average total estimated energy saving for implementing the Cat I EMOs can be over 1% of the total energy consumption of the building whereas the savings through

Cat II and Cat III EMOs would vary depending on the energy saving measures and the necessary investment, with consideration of the estimated payback period and operational needs of the occupants.

The sophistication of an energy audit refers to the scope and the extent to which investigations should be conducted, and which findings should be analyzed for energy efficiency and conservation improvement. Based on the available resources, the size and type of building and the energy audit objectives, the auditor may choose to carry out an energy audit of different depth and level of investigation for study. In general, according to the depth of study, there are two types of audits, namely the walk-through audit and the detailed audit –

- (i) Walk-through audit - A walk-through audit is the simplest type of energy audit which requires minimum resource deployment to simply check for EMOs that are readily identifiable and to implement them to achieve savings. The audit can be conducted by walking through the building and concentrating on the major energy consuming equipment and systems, with EMOs easily identifiable like over-cooled spaces and energy inefficient lamps being used. Reference to records of equipment ratings, technical data sheets and operation & maintenance manuals etc will be very helpful to assess whether the equipment/systems are operating efficiently or not and the results are included in the energy audit report.
- (ii) Detailed audit - A detailed audit requires adequate staffing and funding and will result in more EMOs identifications and comprehensive analysis of their viabilities. All major equipments/systems are checked with systematic analysis for identification of the EMOs as many as possible. A typical detailed energy audit include –
  - (a) Collection of building information - collect information including general characteristics of the building, technical characteristics of the equipment/systems, their design and O&M records, energy consumption details and past electricity bills, maintenance and refurbishment works schedule etc.
  - (b) Preliminary analysis - analyze the characteristics of every energy consuming elements and compare the operational information against the design or corresponding general engineering practices, in preparation of subsequent audit activities etc.
  - (c) Facility inspection and measurement - go ahead on site inspections and necessary measurements to supplement or verify the information collected and the analysis made. Close co-ordination with the O&M personnel will be

important to obtain a full picture of the system operations and maintenance.

- (d) Identification of EMO – screen and spot the parameters with values and trends that deviate from what would be anticipated or required respectively, taking into account possible changes in operational characteristics of the systems in the building occupation stage, and identify the potential EMOs.
- (e) Assessment of EMO - evaluate the effectiveness of the potential EMOs and carry out comprehensive analysis including calculation of the payback period, normalization of the data and assessing the benefits and impacts to the operation of the building as resulted from the implementation of each EMO.
- (f) Compiling energy audit report - provide the building management a quick overview of the objectives and scope of audit, conditions and performance of the equipment/systems, EMOs identified, recommended actions justified by savings achievable and briefing on implementation plan and any other suggested follow up actions.

### **3. Guidelines on Energy Audit**

With the experience gained from energy audits works done for buildings, the Energy Efficiency Office of the EMSD convened a Working Group on Energy Audit with representatives from the power companies, professional institutions, consultants and contractors, property management companies and developers, academes etc. The Working Group has developed a set of practical guidelines, namely the “Guidelines on Energy Audit”, with an objective to promote good energy audit practices to the private sector. This set of Guidelines was published in April 2004 providing building end-users, building owners, building management, operation and maintenance personnel comprehensive information on how to conduct energy audits, common types of EMOs and typical examples of audit reports writing. The Guidelines also cover wide range of issues including the audit procedures and the required audit skills. In 2007, the set of guidelines was also provided with the Chinese version for easy reference.

### **4. Energy benchmarking and the Hong Kong Energy Efficiency Registration Scheme for Buildings**

Building energy benchmarking serves to provide a means for the building operators to compare the building’s energy performances based on a predetermined energy consumption indicator such as kWh per unit floor area or occupant against a baseline and identify its ranking amidst a group of similar buildings. From the result of comparison, one can know

how well or how poor a building is performing in terms of energy efficiency so that the top management of the concerned building or organization can properly determine the allocation of resources for energy efficiency improvement among other factors. On the other hand, a good or excellent performance from the benchmarking will give boosted encouragement to the building operators and facility management for recognition of their efforts put in energy savings.

By conducting a detailed survey of energy consuming groups in different major categories of buildings in Hong Kong, the EMSD has developed a benchmarking model and the corresponding benchmarking software tool. By entering simple data such as the electricity bill, floor area, number of operating hours, the tool will work out the energy consumption indication level of the user's premises, as well as the percentile in relation to the levels of other similar type of premises in the same sub-group.

As an recognition to building owners and building management companies for enhancement of energy efficiency and conservations through energy audits of their buildings, the EMSD has extended the Hong Kong Energy Efficiency Registration Scheme for Buildings (HKEERSB), which was developed in 1998 in accompanying with the promotion for compliance with the Building Energy Codes in new buildings, to cover existing buildings since 2007. Under the voluntary HKEERSB, an existing building can be registered as having good energy performance if it can satisfy the following registration criteria –

- (a) with annual energy consumption exceeding 500,000 kWh;
- (b) energy audit duly conducted in accordance with the Guidelines on Energy Audit published by the EMSD and the energy audit report is certified by a registered professional engineer in either Building Services, Electrical or Mechanical discipline;
- (c) at least Category I EMOs carried out and certified by a registered professional engineer; and
- (d) energy consumption intensity of the building is within the top 50th percentile of the relevant benchmarking indicator gauged using EMSD's benchmarking tool for buildings.

The registered building will be awarded with a certificate under the HKEERSB as a merit for efforts in maintaining their buildings with an energy efficient performance.

## **5. Energy audit programme for government buildings**

EMSD has been implementing energy audits in government buildings for over 10 years with an aim to reduce energy consumption and set pilot examples to private sectors for promotion of energy efficiency and conservation. The energy audit programme has covered most of the government office buildings with major electricity consumption. The achievements in energy saving are very promising. Over the years, more than 230 government buildings have been audited. Followed by the implementation of all Cat I EMOs, an estimated annual saving of 23 million kWh has been achieved. The environmental benefit of the programme included annual power plant emissions mitigation of over 16,000 tonnes of carbon dioxide.

Amongst the government office buildings that have completed with energy audits, results of two typical examples, i.e. a 38-storey government building mainly used as offices and a 12-storey government building of institutional type, are briefly summarized below for experience sharing. The scopes of the audit covered all the energy consuming building services installations in these buildings and the audits were carried out in accordance with the Guidelines on Energy Audit.

Some Cat I EMOs identified in the energy audits include:

- ◆ Switch off some of the lighting at lunch time when the areas are not occupied
- ◆ Discourage the use of personal electrical appliance
- ◆ Increasing the chilled water supply temperature during morning/overtime hours
- ◆ Turning off staircase lighting where daylight is available

The Cat II EMO and Cat III EMO identified in the energy audits of the two government buildings included de-lamping to reduce the illumination level of corridor areas which were over-illuminated and optimization of the primary air-handling units (PAUs) operation by variable frequency drive, etc. The payback period ranged from 1 year to 4 years.

The energy audit reports together with the list of EMOs identified was then passed to the building management for consideration and endorsement. The estimated energy saving of the Cat I EMOs for both buildings were over 1% of the total energy consumption of the buildings which were implemented straight away, while some of the Cat II and Cat III EMOs which involved capital cost investment with disruption to building operation need further detailed planning.

## **6. Proposed mandatory implementation of the BECs**

In the review of the outcome of the HKEERSB after its operation for 10 years, the Government notes that the participation rate of the private sector is disconcertingly low

though much efforts have been attempted by the EMSD in promoting the scheme. Against this background, the Government considers it is now an opportune time to turn the voluntary compliance with the BECs to a mandatory one by legislative means.

The Government launched a 3-month public consultation on the proposed mandatory implementation of the BECs in late December 2007. The proposal in the consultation document suggests mandatory compliance of certain energy efficiency requirements for specified types of new and existing buildings. For the new building category, commercial buildings and communal areas of residential buildings and industrial buildings shall comply with the requirements of the BEC upon construction completion. For the existing building category, compliance with the BEC requirements will be required when major retrofitting works are carried out in these types of buildings. In addition, all commercial buildings larger than a specified area shall also have an energy audit conducted once every 10 years, and the results of the audits shall be exhibited in the concerned building or premises.

Exhibition of energy performance of commercial buildings and premises will drive owners, occupiers and properties management companies looking for improvement for better building energy performance to achieve good business image. Though the implementation of relevant EMOs are not made mandatory under the proposal, it is believed that the self-driving force created by the cost effectiveness of the EMOs will create a momentum for building owners and business operators to improve their buildings and premises by implementing those EMOs with foreseeable benefits.

Under the proposed legislative scheme, compliance with the BECs and the results of the energy audits shall be certified by professionals recognized by the EMSD to ensure that all energy efficiency works are carried out in a professional manner.

## **7. Results of the public consultation**

The public consultation of the proposed mandatory implementation of the BECs ended in March 2008. It is encouraging that there is overwhelming support from various sectors including Legislative Council, District Councils, the green groups, the professional bodies, the trade associations, the political groups and the general public, etc. on the principle direction of the legislative proposal.

In regard to the proposed requirement for commercial buildings to have an energy audit once every 10 years, fair extent of support and no critical objection from the public was received. There are views and suggestions that the scope of energy audit should be well defined and the

interval of energy audit should be reviewed where necessary with due consideration of the possible gain in energy saving from the existing building category and the cost effectiveness of audits. The requirement for display of energy audit results should be carefully examined on the ground of commercial confidentiality reason and possible potential impact to business operation. Grace period and proper phasing of the energy audit works for the large bulk of existing commercial buildings should be considered to smooth out the implementation taking into account the amount of work force in the market.

## **8. Latest development of the mandatory proposal**

The implementation details of the legislative proposal are being fine tuned to ensure that the legislation could be accepted by the stakeholders in the trade and the general public at large, taking into consideration the views and suggestions received in the public consultation exercise. Immediate after the completion of the public consultation exercise, the EMSD has established a Technical Task Force comprising representatives from professional bodies, electrical & mechanical contractors' associations, properties management companies and estate development associations, academes as well as other government works departments to prepare and review relevant energy efficiency standards of building services installations and the detailed requirements of energy audits. It is intended that a code of practice for energy audit, based on the existing Guidelines on Energy Audit, will be compiled to set out the practical requirements of energy audits as required under the coming new legislation.

Subject to the views received in subsequent preparation of the details of implementation of the legislation, the Government now plans to introduce the legislative proposal into the Legislative Council for consideration in 2009.

## **9. Conclusion**

Energy audits, either walk-through audits or detailed audits, are essential for building sectors to promote a better understanding of the energy performance of existing buildings. The audits will create awareness among those who are involved in the property management as well as operation and management of the buildings, justify the necessity for energy efficiency improvement through the implementation of the EMOs and provide opportunities for building owners and tenants to pay less in their electricity bills.

Energy audits in itself will not lead to energy savings. They need to be followed by actions. Mandatory energy audits make it right from the beginning that a possible reduction in energy



consumption can be achieved in a relatively short period of time. Implementation of the Cat I EMOs should not incur any major burdens to the building operators. Combining the development of energy performance contracting in the industry and the incentives from the cost-effectiveness of the energy saving measures, building owners may consider implementing the Cat II and Cat III EMOs which require initial investments for energy savings.

The Government will exercise extreme care in developing the mandatory requirements on energy audits to ensure that they would become processes helping commercial business and building operators to reduce their operating cost or to make their business more competitive capable in the market, and do not form a perception as an administrative or financial burden to the building owners and property management companies in their operation and management of their buildings.

#### References –

- 1) The BEC & HKEERSB available at:  
[http://www.emsd.gov.hk/emsd/eng/pee/eersb\\_pub\\_cp.shtml](http://www.emsd.gov.hk/emsd/eng/pee/eersb_pub_cp.shtml)
- 2) Guidelines on Energy Audit available at:  
<http://www.emsd.gov.hk/emsd/eng/pee/em.shtml>
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- 4) Consultation Paper on the Proposed Mandatory Implementation of the BEC issued by Environment Bureau and Electrical & Mechanical Services Department on 28 December 2007
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