Enhancing Buildings Energy Performance Towards Carbon Neutrality by Regulation and Collaboration

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ABSTRACT

The Chief Executive of the Government of Hong Kong Special Administrative Region has stated in the 2020 Policy Address that Hong Kong will strive to achieve carbon neutrality before 2050 and subsequently the Government announced Hong Kong's Climate Action Plan 2050 in October 2021 which outlines the four major decarbonisation strategies.

Transition to "Net-zero Electricity Generation" comes at a price while the effort on "Energy Saving and Green Buildings" to reduce the overall electricity consumption can lower the cost of decarbonisation. Therefore, the Hong Kong's Climate Action Plan 2050 sets up targets to reduce the electricity consumption of commercial buildings by 30% to 40% and that of residential buildings by 20% to 30% from the 2015 level by 2050, and to achieve half of the above targets by 2035.

The major building services installations are the main source of electricity usage in buildings. With the enactment of the Buildings Energy Efficiency Ordinance (BEEO) in 2012, the compliance of the energy efficiency requirements of building services installations specified in the Building Energy Code (BEC) and the Energy Audit Code (EAC) are mandated. To achieve the carbon neutrality goal and to keep abreast of latest technological development, international standards and public aspiration, the BEC and EAC would be reviewed at least once every 3-year.

This paper gives an overview of the BEEO since its full implementation and highlights the progressive changes of BEC and EAC. Strategic review on the 10-year of BEEO development with the aim of fostering new opportunities of building energy efficiency performance optimization and to pursue tripartite collaboration among the community, the business sector and the Government would be essential to lower the cost of decarbonisation for all.

Keywords:

Buildings Energy Efficiency Ordinance, Building Energy Code, Energy Audit Code, Carbon Neutrality

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1. INTRODUCTION

To go further in deep decarbonisation, the 2020 Policy Address announced that Hong Kong would strive to achieve carbon neutrality before 2050, which the Government will update the Hong Kong's Climate Action Plan 2030+ to set out more proactive strategies and measures to reduce carbon emissions. The Hong Kong's Climate Action Plan 2050 was published on 8 October 2021 setting out the vision of "Zero-carbon Emissions-Liveable City-Sustainable Development", and outlining the four main decarbonisation strategies and targets for combating climate change and achieving carbon neutrality.

Electricity generation is Hong Kong's largest source of carbon emissions (about 66 %). To adopt "Net-zero Electricity Generation", it is unavoidable that a substantial amount of capital need to invest to expedite the use of clean zero-carbon energy and inevitably put upward pressure on electricity tariffs. The contribution on "Energy Saving and Green Buildings" can reduce the overall electricity consumption and thus, can lower the cost of decarbonisation. Therefore, the Hong Kong's Climate Action Plan 2050 sets up the targets to reduce the electricity consumption of commercial buildings by 30% to 40% and that of residential buildings by 20% to 30% from the 2015 level by 2050, and to achieve half of the above targets by 2035.

Hong Kong, as an international financial centre, is a densely populated metropolitan city crowded with high-rise buildings and the buildings in Hong Kong contribute to about 90% of the city's total electricity consumption. Unsurprisingly, the building services installations are the major source of electricity usage in buildings. Since 21 September 2012, the Buildings Energy Efficiency Ordinance (BEEO) came into full operation specifying the requirements to comply with the Building Energy Code (BEC) in respect of regulating the minimum energy efficiency standards of the design of building services installations in newly constructed buildings and major retrofitting works in existing buildings; and requiring owners of commercial buildings to conduct energy audit according to the Energy Audit Code (EAC). The BEEO applies to four key types of building services installations namely lighting installations, air-conditioning installations to enhance energy efficiency of building services installations. It gives a solid legislative foundation to enhance energy efficiency of building services installations and promote decarbonisation of buildings through the mandatory implementation of the BEC and EAC.

2. REGULATORY REGIME OF THE ORDINANCE

2.1 Certificate of Compliance Registration (COCR)

To effectively reduce the energy consumption, we must ensure that suitable energy efficient design provisions should be incorporated into the planning and design of the building. Newly constructed buildings that could perform well on energy efficiency at occupation stage is crucial for better livability and supporting low-carbon transformation. The prescribed building services installation (BSI) in a newly constructed building (i.e. a building with the consent for superstructure construction works) should comply with the requirements in the BEC. The developer of a building is required at the building design stage (within 2 months after obtaining the consent to the commencement of building works issued by the Building Authority) to submit to the Electrical and Mechanical Services Department (EMSD) a "stage one declaration" to undertake BEC compliance of the design of building's BSIs, and the declaration has to be certified by a Registered Energy Assessor (REA). Subsequently at the occupation approval stage (within 4 months after obtaining an "occupation permit" issued by the Building Authority), the developer is further required to submit a "stage two declaration" certified by a REA to declare the site installation in compliance with the BEC, and apply a COCR from EMSD for the building. The building owner and the responsible person of a unit of that building must maintain the BSI to a standard not lower than the edition of BEC applied in that COCR.

2.2 Major Retrofitting Works (MRW)

Energy saving in existing buildings must be a long-term, on-going part of our work to achieve our targets for combating climate change and achieving carbon neutrality. Many existing buildings, including older buildings, have great potentials to perform better through retrofitting. When major retrofitting works (MRW) are involved in a unit or common area, irrespective of newly constructed prescribed buildings or existing prescribed buildings, the owners or responsible persons are required to obtain from REA for a Form of Compliance (FOC) certifying the MRW's compliance with the BEC. Indeed, MRW refers to the addition or replacement of BSI covering a works floor area aggregated to 500m² or above, or the addition or replacement of a central building services installation (CBSI) component including an electrical circuit at rating 400A or above; a chiller/air-conditioner at 350 kW cooling/heating capacity or above; or a motor drive plus mechanical drive of a lift or escalator. Same as that for COCR, the BSI or CBSI issued with a FOC must be maintained to a standard not lower than the edition of BEC applied in that FOC.

2.3 Energy Audit Code

The EAC is another tool under the BEEO to assess the energy performance of buildings and recommend appropriate energy management opportunities (EMO) for the building owners' consideration. The BEEO requires the carrying out of energy audit for the CBSI in commercial buildings and commercial portion of composite buildings every 10 years in accordance with the scopes specified in the EAC. After the audit, the energy utilization index (EUI) of that building which reflects its energy intensity or energy performance has to be identified and exhibited. In addition, EMO has to be identified for building owners to realize the possible savings of the building and to further consider the implementation plan by taking into account various factors including resources, pay-back period, and influence to operations, etc. as analyzed in the energy audit.

2.4 Implementation

On 21 September 2022, the BEEO completed its first ten-year steadfast and successful mission of combating climate change. As of August 2022, the BEEO has covered about 1,800 COCR for newly constructed buildings, about 12,000 FOC from buildings that have completed MRW and about 2,600 energy audit report from commercial buildings / commercial portion in the composite buildings (Figure 1). The above ten-year achievements in energy saving in green buildings not only captures Hong Kong's significant achievements in promoting building energy efficiency and reducing carbon emissions over the past decade, but also manifests the full and active participation of the whole community in pursuing low-carbon transformation for advancing towards the goal of carbon neutrality together.



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3. THE REVIEW OF BEC AND EAC

3.1 Uplifting of the Energy Efficiency Standards

Following the enactment of the BEEO in 2012, the BEC and the EAC were promulgated in the same year and will review once every three years to keep the codes abreast of the times. Three comprehensive reviews have been conducted and the energy efficiency standards and requirements of building services installations in the codes are progressively adjusted and augmented for continuous improvement of the building energy performance in Hong Kong.

The tightened and the new requirements on the four prescribed building services installations as stipulated in the latest 2021 edition of BEC (BEC 2021) are formulated based on the global development of relevant technology and energy efficiency standards to further enhance the overall energy efficiency performance of buildings. The BEC 2021 uplifts the energy efficiency standards with an improvement of more than 15% as compared with the 2015 edition of BEC (Figure 2). By 2035, the estimated annual energy saving is expected to bring about an annual energy saving of around 4.7 billion to 5.3 billion kWh from buildings in Hong Kong (compared with 2015), which will contribute to the decarbonisation journey of Hong Kong to achieve the carbon neutrality target before 2050.



The reviews of the BEC and EAC are conducted by a technical taskforce with members from the relevant professional institutions, trade associations, consultants and contractor associations, university academia, government departments and utilities companies. Six working groups are formed under the technical taskforce to provide expertise advice on the possible improvements to the energy efficiency standards and requirements under BEC and EAC (Figure 3).



In the course of review process, the data collected from the BEEO submissions, technology advancement on equipment and control, benchmarking of the energy efficiency standards adopted by internationally-recognized bodies and other well established authorities, feedback and suggestions from the relevant trades and operators through the technical taskforce and working groups, aspiration from public stakeholders, etc. are taken into consideration.

In the last review exercise, over one year of preparation works in advance with further fifteen numbers of meetings in six months were separately arranged for the members from the technical taskforce and working groups. It had set up a platform to focus on specific agenda and proposed amendments on the codes and to facilitate the communication and collaboration to address the comments received from the stakeholders. The 2021 edition of the BEC and EAC (i.e. BEC 2021 and EAC 2021) were finally gazetted with a press release on 31 December 2021.

Having taken into account the preceding practice and the operational need of relevant trades, grace periods of six-month and nine-month respectively have been provided for developers of new buildings and owners of existing buildings to get prepared for the implementation of BEC 2021 and EAC 2021. For new buildings, the BEC 2021 is already in effect on 1 July 2022 in respect of the issues of "stage one declaration" by the developer under the BEEO. For MRW in existing buildings, the BEC 2021 is already in effect on 1 October 2022 in respect of the issues of FOC by the REA under the Ordinance. The EAC 2021 applies to the energy audit being completed on or after 1 October 2022.

The key amendments from the updates of BEC 2021 and EAC 2021 are as follows:-

3.1.1 Lighting Installation

Besides tightening the prevailing design parameters, the review also introduces new light spaces to give more clarity on the compliance. Major amendments are listed below:

- Tighten the lighting power density (LPD) requirement for certain types of spaces
- Widen the coverage with addition of new space and LPD requirement
- Extend the requirement of automatic lighting control (ALC) to cover more spaces
- Tighten the activation time of ALC requirement in car park

3.1.2 Air-Conditioning Installation

Besides uplifting the energy performance of various major equipment such as chiller and unitary air-conditioner, variable refrigerant flow system etc., the review also introduces new requirements on chilled water temperature reset. Major amendments are listed below:

- Upgrade the coefficient of performance for different type of air-conditioning systems
- Expand the requirement of variable flow of chilled water pumping system
- Introduce chilled water temperature reset control requirement and provision for chiller plant

3.1.3 Electrical Installation

The review particularly focuses on the increasing demands on the charging facilities for electric vehicles (EV) within the buildings and the provision of metering devices to separate the electricity consumption measurement for these facilities are added. Major amendments are listed below:

- Clarify the motor efficiency requirement for motors equipped with variable speed drive
- Strengthen the provision of metering devices for charging facilities for EV

3.1.4 Lift & Escalator Installation

The review includes the tightening of existing design parameters as well as widen the adoption of lift regenerative braking system. Major amendments are listed below:

- Tighten the maximum electrical power input for lift installation
- Tighten the maximum decorative load for lift
- Widen the requirement on lift regenerative braking system

3.1.5 Performance-based Approach

The performance-based approach provides an alternative approach to comply with the BEC. This approach focuses on estimating the total energy consumption of a building using energy simulation software. With this approach, the energy savings from energy efficient features and renewable energy installation can be evaluated in a systematic manner and the capital cost and environmental benefits can be made known to the building owner at the building design stage for holistic consideration and assessment. The review focuses on the possible ways to promote the adoption of performance-based approach for BEEO submission by allowing higher flexibility on the building shall be lower than the baseline as per the minimum requirement specified under the BEC. Adopting performance-based approach can encourage building owners to further optimise the energy efficiency performance of their buildings beyond statutory requirements and there are added benefits in using the energy model for evaluation of energy efficient design options in achieving outperformance to the BEC.

3.1.6 Energy Audit

The Government announced the Hong Kong Roadmap on Popularisation of Electric Vehicles on March 2021 to promote the adoption of EV, such that there are no new registration of fuelpropelled private cars including hybrid vehicles by 2035. The Government also set up the EVcharging at Home Subsidy Scheme and extend with additional funding to total \$3.5 billion to support installation of EV charging-enabling infrastructure (i.e. cover around 140,000 parking spaces) for the existing private residential buildings. It is anticipated that the portion of energy consumed by the vehicles in transport sector would shift to the building sector on the coming years. Therefore, the review focuses on extending the scope on auditing the energy consumption for charging facilities for EV, such that the building owner can have a better understanding on the trend of energy use on EV and maintain sufficient data to separately review the actual energy consumption by the CBSI in the building when necessary.

After the full implementation of the BEEO in 2012, the first energy audits for existing commercial buildings and the commercial portions of composite buildings have been successfully completed. The second energy audits for these buildings will soon commence after 10 years of the first energy audits. The review supplements further elaboration in the EAC 2021 to require the building owners to evaluate the implementation of EMO and comparison of EUI of the building with previous energy audit. It facilitates the building owners to assess the improvement of EUI of their buildings and the effectiveness on carrying out the EMO, which aimed to enhance the regular monitoring on building energy consumption and further planning on continuous improvement on building energy efficiency.

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3.2 Technical Guidelines

To assist the trade and practitioners in understanding the technical requirements in the BEC 2021 and the EAC 2021, the respective Technical Guidelines on Code of Practice for Energy Efficiency of Building Services Installation 2021 Edition (TG-BEC 2021) and Technical Guidelines on Code of Practice for Building Energy Audit 2021 Edition (TG-EAC 2021) are launched on July 2022 (Figure 4). This set of technical guidelines gives an overview and certain explanations of the legislative requirements and provides further elaborations and clarifications on the engineering requirements of BEC 2021 and EAC 2021, with illustrative tables, diagrams and examples to ease the trades' concern.



4. STRATEGIC REVIEW ON THE LEGISLATIVE REQUIREMENTS

In order to strive for carbon neutrality before 2050, we need to step up efforts in promoting energy conservation, and be more proactive to look for further decarbonisation opportunities in buildings. By making use of the prevailing legal basis of the BEEO, we need to adopt a multi-pronged approach and strategically identify new initiatives to explore the feasible options to further enhance the energy performance of buildings.

4.1 Expanding the Scope of Regulation to cover High Energy Consumption Buildings

The BEEO covers specified types of private and public buildings. There are total 13 types of prescribed buildings under the BEEO which cover majority of building types in Hong Kong. For residential buildings and industrial buildings, the BEEO only governs building services installations in common areas of these buildings currently. For the units in residential buildings, EMSD's Mandatory Energy Efficiency Labelling System (MEELS) will be one of the effective

tools to raise the public awareness on energy saving, which aimed to facilitate the public to choose energy efficient home appliances in the units and put the trade to progressively improve their products. For industrial buildings, it is observed that there are increasing numbers of conversion of existing industrial buildings into data centres (i.e. at Tsuen Wan, Kwai Chung, Shatin, Kwun Tong, Kowloon Bay, San Po Kong, Chai Wan, etc.) as well as new data centres being built in industrial estates (i.e. at Tseung Kwan O and Tai Po) which the current regulatory regime under the BEEO is only covering common area of industrial buildings.

According to the tracking report on data centres and data transmission networks issued by the International Energy Agency (IEA) on September 2022, the global demand for digital services is growing rapidly. Since 2010, the number of internet users worldwide has more than doubled, while global internet traffic has expanded 20-fold. The global data centre electricity use in 2021 was 220 – 320 TWh, which is around 0.9 - 1.3% of global final electricity demand. EMSD has been keeping track on the electricity use in data centre since 2018. Based on data retrieved in year 2018 (4,030 TJ), year 2019 (4,446 TJ) and year 2020 (5,300 TJ) which were published in EMSD's Hong Kong Energy End-Use Data 2020, 2021 and 2022, a continuous upward trend of around 10.2% (at year 2019) and 19% (at year 2020) are observed and the overall electricity use of data centres are equivalent to approximate 3.3% of Hong Kong electricity demand in year 2020. Based on a study report from the Office of the Government Chief Information Officer (OGCIO), it forecasts that the supply of the data centre floor space will rise by over 50% from approximately 700,000 m² as of 2019 to over 1,100,000 m² by 2025 which would further blooming up the electricity demand.

Data centres are an important I&T infrastructure essential for Hong Kong's sustained economic growth. In recognising the associated energy and environmental concerns due to the accelerating demand for data services, data centres should be aimed for green and high energy efficient design. There are mutual benefits to the building operator for reducing the electricity consumed and lower the operational cost while the power companies can relief the further burden on the cost of transformation to zero-carbon energy. Looking ahead, it is worthwhile to explore the possible ways to widen the coverage of the BEEO to data centre, and also look into buildings with high energy consumption.

4.2 Conducting Energy Audits More Frequently and Mandating the Implementation of Identified EMO

There are numbers of existing buildings, including older buildings, have potentials to perform better on energy efficiency. Greater use of energy management tools for existing buildings via energy audit are considered as the specific initiative for review and to further enhance the energy savings effect beyond the original requirements.

Achieving carbon neutrality in less than 30 years is a tremendous challenge. The BEEO currently required the building owners of commercial buildings and commercial portion of composite buildings to carry out the energy audit for every 10 years. There is imminent need to shorten the period of the 10-year interval of mandatory energy audit, such that more frequent energy audit would be conducted before the medium-term and long term targets of reducing the electricity consumption of commercial buildings in 2035 and 2050 respectively.

For each round of energy audit, it provides a good opportunity to enable and motivate building owners to improve their building energy performance by making reference to their own past performance, as well as the neighborhood buildings in similar nature. The systematic review on the energy consuming equipment / systems in buildings to identify suitable EMO with detailed payback analysis can provide useful information for the building owners to formulate and implement recommended improvement measures to achieve better energy savings. Further deliberations are required to foster the implementation EMO and explore possible mechanism to evaluate the factors, such as suitable types of EMO, proportion of target savings by the execution of EMO, reasonable timeframe, etc., to put forward as the considerations on mandating the implementation of identified EMO in existing buildings.

In long run, more frequent energy audit will be beneficial to keep closer track on the trend of energy usage of the existing buildings and assist the building owners to set up energy saving targets for on-going improvement. For newly completed commercial buildings under BEEO, the first mandatory energy audit can also be conducted within a shorter timeframe which can assist the building owner to spot out possible EMO in catering the changes in operation after the tenants move-in for earlier energy saving. Last but not least, it is also worth to explore the possibility to widen the coverage of energy audit to high energy consumption buildings to further contribute the carbon neutrality goal.

5. COLLABORATION WITH DECARBONISATION FOR ALL

Along the decarbonisation journey for Hong Kong, we should pursue tripartite collaboration that involves the community, the business sector and the Government in continuous refinement of energy saving strategies. The whole community must also work hand-in-hand for the transformation and adoption to live in a low-carbon life style in order to reduce the electricity consumption of buildings and meet the targets set up in the Climate Action Plan 2050.

EMSD has been continuously promoting energy efficiency standards and requirements by different publicity channels and outreaching programmes to the public and key stakeholders for their better understanding of the BEEO and compliance. A large variety of publicity means, such as leaflets, pamphlets, internet, seminars, briefing sessions, TV announcements, etc. have been utilised to engage the public and key stakeholders of both private and public sectors including professional institutions, developers, property management companies, universities, government departments and trade association, etc., to keep abreast of the latest development of the BEEO and the codes.

To achieve the aforesaid targets, we should foster new opportunities for energy saving. Green Innovation and Technologies (I&T) plays a pivotal role in achieving the carbon neutrality targets in a more proactive approach. Engagement with stakeholder in the community on green I&T development, adoption and collaboration would become more and more important.

6. CONCLUSION

With the full implementation of the BEEO since 2012, the BEEO has been serving as the key drivers of enhancing building energy efficiency, Hong Kong has taken the major step forward from voluntary basis to mandatory requirements in addressing the impacts of carbon emission brought by buildings energy consumption. The regular reviews of the codes pave the way for further enhancement of the standards and reinforces the roothold of minimum energy efficiency standards of BEC & EAC.

After 10 years of implementation of the BEEO and the new reduction targets of electricity in commercial buildings and residential buildings set up under the Climate Action Plan 2050, EMSD will continuously review and strengthen the energy efficiency standards and explore the feasible options (with the legislative amendments when necessary) at suitable time intervals. EMSD will also collaborate with the stakeholder and trade to move forward to explore the energy saving opportunities arising from green I&T, and strive for technological breakthroughs in the application of big data and artificial intelligence to optimise the energy performance of

buildings in the pursuit of enhancing the building energy efficiency and to strive towards carbon neutrality.

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