Policy Scenarios of Zero Carbon Building for Hong Kong: To Survive or To Lead?

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ABSTRACT

During the past decade 'zero carbon' building policies have been formulated in a number of countries. In Hong Kong, despite the over 20 years of evolution of building energy codes, there is still no policy agenda of achieving possible zero carbon for buildings. General perception exists on the infeasibility of high-rise buildings particularly in the subtropical climate such as Hong Kong. This paper aims to develop policy scenarios of zero carbon building (ZCB) for the high-rise context of Hong Kong. The research was conducted through the integration of a questionnaire survey, follow-up interviews, series of focus group meetings, and a policy forum, which together engaged over 600 professionals and stakeholders in Hong Kong over a 15-month period. A definition of ZCB for Hong Kong is developed and so is a socio-technical systems ZCB policy framework, elaborating four technical components, i.e. definition and scope, measure and indicator, target and timeline, and renewable energy, within their social, regulatory and geographical contexts. Policy scenarios are developed for different building types and sectors from the status quo towards the UN's 2050 carbon neutrality target. Important opportunities are identified for addressing climate change as well as re-shaping energy and infrastructure planning in Hong Kong, whilst significant risks are also discovered with technological constraints and reluctant behavioural changes. The opportunities are found to outperform the risks. To realise the policy scenarios requires the adoption of the recommended strategies, aiming a leading model rather than survival. Key to that is to strengthen the partnership between government, industry, universities and communities. To survive or to lead for Hong Kong in the strategic future of high-rise ZCB is not a policy decision per se, but a socio-technical debate provoking an institutional paradigm shift.

Keywords: *zero carbon building, energy policy, carbon emission, carbon policy*

1. INTRODUCTION

During the past decade 'zero carbon' or 'zero energy' building policies have been formulated in a number of countries. In Hong Kong, despite the over 20 years of evolution of building energy codes, there is still no policy agenda of achieving possible zero carbon for buildings. In addition, research on ZCB policy and its associated opportunities and risks in Hong Kong has been limited. In 2011 the Council for Sustainable Development in Hong Kong launched a public engagement process on energy saving and carbon emission reduction in buildings, and provided recommendations of 'systemic enhancement' and 'facilitation of behaviour change' to help engage the community, but did not explore the opportunities and risks of possible strategic movement towards zero carbon. As observed by Crawley et al., a common language in defining and measuring ZCBs is lacking, which contributes to significant ambiguity when setting targets and procedures to achieve carbon reduction.

This paper aims to develop policy scenarios of zero carbon building (ZCB) for the high-rise context of Hong Kong. A definition of ZCB for Hong Kong is developed and so is a socio-technical systems ZCB policy framework. Policy scenarios are developed for different building types and sectors from the status quo towards the UN's 2050 carbon neutrality target. The opportunities and risks associated with the formulation and implementation of this ZCB policy are identified, including their relevant technical, regulatory, social and geographical aspects. These provide evidence of the potential benefits of this policy to inform the HKSAR Government's policy decisions. Recommendations are developed to realise the opportunities and mitigate the risks identified.

2. RESEARCH METHODOLOGY

The research was conducted through the integration of a questionnaire survey, follow-up interviews, series of focus group meetings, and a policy forum, engaging professionals and stakeholders in Hong Kong over a 15-month period.

The questionnaire survey approached over 1000 informed professionals and stakeholders in Hong Kong industry and society. In total 260 questionnaires were returned, of which 235 were properly completed, thus yielding an overall response rate of 235 for analysis. Followed by the questionnaire results, semi-structured interviews, four focus group meetings and one discussion forum were conducted to further explore and verify the results. Table 1 illustrates the number of participants involved in each research activities. The participants cover all eight stakeholder groups including developers, clients and investors, estate and facilities managers, contractors, professional advisors, manufacturers and suppliers, government and its departments and agencies, financers, bankers and mortgage lenders, and universities and professional bodies.

Items	Questionnaire survey	Follow-up Interviews	Four Focus group meeting	Discussion forum
Number of participants	235	30	105	248

Table 1: Study components and number of participants

3. RESULTS AND ANALYSIS

The proposed ZCB policy for Hong Kong has drawn on the socio-technical systems policy framework of our previous research, which highlights a ZCB policy as a complex socio-technical system. The technical system of a ZCB policy consists of four components: definition and scope, targets and timelines, measures and indicators, reliance on renewable energy. This technical system should be embedded into the regulatory, social and geographical contexts. Stakeholder engagement is an important mechanism for formulating and implementing the policy. The four components of the technical system of the ZCB policy, in addition to the regulatory, social and geographical contexts and the mechanism of stakeholder engagement, form the core of the proposed ZCB policy for Hong Kong.

3.1 Policy scenarios of Zero Carbon Building for Hong Kong

3.1.1 ZCB definition and scope

The ZCB definition developed for Hong Kong regards ZCBs as complex socio-technical systems, and recognises the multidimensional boundaries of the ZCB systems and the wide-ranging stakeholder group engagement. The generic definition of a ZCB (or a LCB) is a building within its defined systems boundaries with net-zero (or very low) carbon emissions on an annual basis during the operational stage of the building. The systems boundaries should be defined in terms of the technical components of the definition within the relevant regulatory, geographical and social contexts (for a detailed explanation see [5]).

3.1.2 ZCB policy target and timeline

Different ZCB policy targets and timelines were proposed for different building types and sectors in Hong Kong, using the policy targets and priorities adopted in the UK as a point of reference. Considering three variables, namely, building type, sector and status, eight combinations of policy targets were considered in eight typologies, and preliminary timelines for these targets were also proposed (Figure 1). Their feasibility was examined through the stakeholder questionnaire survey and interviews.

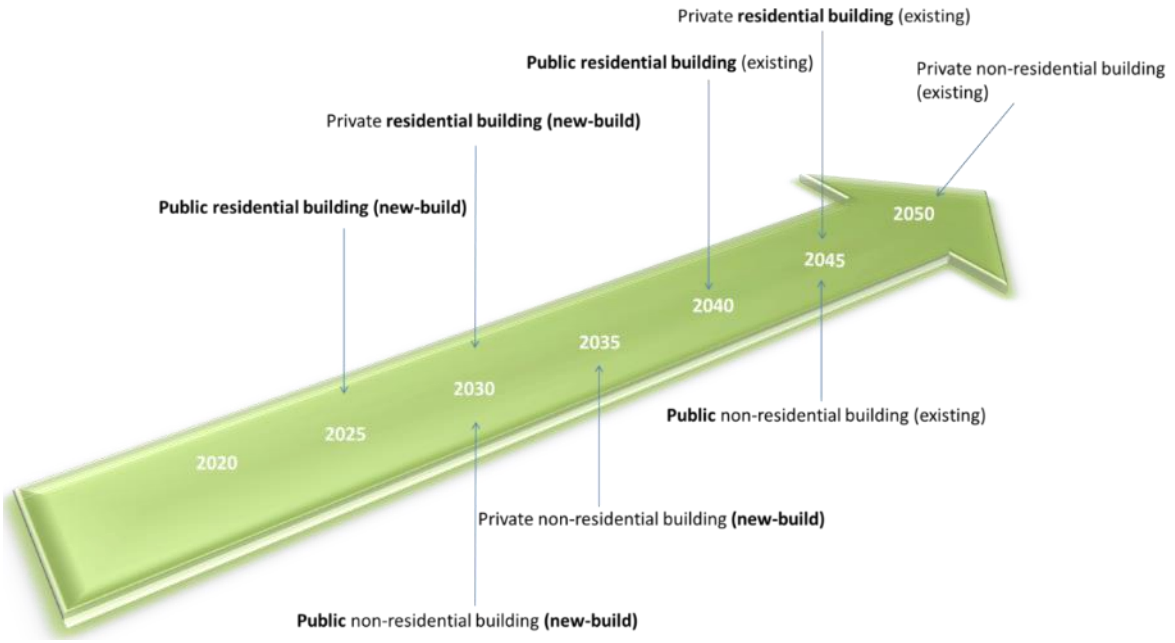

Figure 1: Possible ZCB policy targets and timelines for study

All buildings in Hong Kong were proposed to achieve net zero carbon as defined above by 2050. To enable a progressive approach, all newly built public residential buildings were prioritised to achieve net zero carbon from 2025. The other policy targets were proposed to follow up, with a five-year period of catching up, and with existing private non-residential buildings as the last target by 2050.

3.1.3 Measures and indicators

Performance measurement is important to ensure the effective implementation of the proposed policy. Use of kgCO2e/m2/year was suggested as a measure of carbon emission intensity (CEI) and kWh/m^2/year to measure energy use intensity (EUI), as these are common measures both worldwide and in Hong Kong. For consistency, the gross floor area (GFA) of a building was proposed for calculating the EUI and CEI, denoting the area contained within the outer surface of the external walls and measured at each floor level, with any portion of this area not floored over also included. Both regulated and unregulated operation energy should be counted.

3.1.4 Use of renewable energy

The energy supply is a major contributor to carbon emissions in Hong Kong, with 53% of the fuel mix from coal, 23% from nuclear energy, 22% from natural gas and remaining 2% from others. The increased adoption of renewable energy is crucial to reduce reliance on fossil fuels and reduce carbon emissions. Hong Kong has abundant sunshine, and solar energy has the greatest potential for use, such as solar thermal systems for water heating or refrigeration and PV systems for electricity generation . Wind power has been proposed as an alternative, but its low efficiency and effect on the natural environment have generated substantial debate about its applicability in Hong Kong. Energy from municipal solid wastes (MSW), particularly the organic fraction, has also been emphasised as a valuable source of electricity. The HKSAR Government has proposed targets to reduce carbon intensity by 50–60% of the 2005 level by 2020, and to utilise renewable energy at about 3–4% of the fuel mix in ways of two wind farms and integrated water management facility.

Given the limited use of renewable energy in Hong Kong, it was proposed that the required renewable energy for a ZCB may be generated on- or off-site and directly connected with the building and/or off-site and indirectly connected with the building.

3.2 Perceptions of the ZCB definition and policy scenarios

Overall, most participants recognised that Hong Kong should initiate a ZCB policy, or at least set relevant energy-reduction targets to facilitate the sustainable development of the city. The majority of questionnaire respondents agreed or strongly agreed that Hong Kong lacks a strategic policy leading to zero carbon emissions, that Hong

Kong needs to develop such a policy and that this is a global trend (71%); and that a ZCB policy is important for Hong Kong (80%). However, opposed views still exist. These attitudes were explained through the follow-up interviews and focus group meetings by a perception that the existing building energy policies and ordinances were capable of reducing building energy use and carbon emissions; and a perception that achieving zero carbon in Hong Kong lacked feasibility due to the high-rise, high-density nature of its buildings. Some also argued that many steps are required before achieving zero carbon emissions and thus a low-carbon or low-energy building policy may be more practicable.

During the survey, focus group meeting and discussion forum, there was a consensus on the proposed measures and indicators, but much division and discussion of other parts of the technical system of the policy, including definition and scope, timelines and targets, and renewable energy.

Over two thirds (67%) of the questionnaire respondents agreed or strongly agreed with the proposed definition, while others held a neutral or disagree attitude. Possible reasons were identified through the follow-up interviews and focus group meetings as uncertainty about a true definition; lack of clarity about the definition of system boundaries in the definition; whether embodied energy should be considered; and different ZCB considerations for different types of building.

There was a division of views on the timeline and target, most respondents (61%) agreed that public buildings should be prioritised over private ones, but more than half (52%) disagreed with prioritising residential over non-residential buildings. Interviewees and focus group participants explained that although many other countries or cities prioritises residential buildings over non-residential, this may be unsuitable for Hong Kong due to the high-rise, high-density characteristics of residential buildings. In addition, the user behaviour factor of residential occupants (generally perceived as reluctant to change) may make it more difficult to achieve zero carbon in residential buildings in Hong Kong. In the follow-up interviews, most agreed that policy targets and timelines should set the same pace as the international approach, but that it was unlikely the target would be achieved by the proposed time. This perceived low possibility of the target fulfilment was attributed mainly to the high-rise, high-density building, difficulties with renewable energy, political uncertainty, and lack of industry and public willingness for zero carbon in Hong Kong.

While renewable energy is one of the most important strategies for achieving ZCB, the feasibility of applying many technologies in Hong Kong has long been doubted. The achievability of renewable energy like solar energy, combined cooling, heat and power (CCHP) plant was considered high from the questionnaire survey, but doubted during follow-up interviews and focus group meeting. One participant suggested that the results of questionnaire survey may not be useful as the general public lack technological knowledge, and it would reflect their misunderstanding of the use of some forms of renewable energy, the associated power generation and the potential benefits and risks.

Not surprisingly, most questionnaire respondents (65%) agreed that implementing the possible ZCB policy in Hong Kong would be difficult. Through follow-up interviews and focus groups, possible reasons that emerged were that the difficulty lies in industry not trying because the policy is not compulsory. The questionnaire survey results also demonstrate the view that the willingness of both industry and the public to support the ZCB policy is neutral or even weak, and that to gain such support the government should take the lead with more incentives.

3.3 Opportunities, risks and recommendations

The importance of possible opportunities to formulate and implement the proposed ZCB policy, as well as the potential risks, was examined in the technical, regulatory, social and geographical aspects. Raising public awareness of sustainable living was considered the most important opportunity, followed by promoting strategic urban planning for long-term city development, and cutting building energy consumption. The major hurdles were identified in the geographic and technical aspects, particularly the geographical difficulties for domestic renewable energy generation, heavy reliance on fossil fuels, and resistance of practitioners to support the policy due to uncertain benefits. To realise the opportunities and mitigate the risks, the important recommendations were recognized as the encouragement of energy and carbon reduction through urban planning, the demonstration of life cycle economies and cost benefits of ZCB, and including zero carbon/energy targets in public project procurement.

4. DISCUSSION

Drawing on a critical literature review and desk study of ZCB policies, initiatives, demonstrations and the like worldwide and the evolution of policies on building energy and carbon emissions in Hong Kong, a potential ZCB policy for Hong Kong was proposed. This proposed policy adopts the socio-technical systems framework which regards ZCB policies as complex socio-technical systems as presented by Pan and Ning [4]. The technical system of the proposed ZCB policy consists of four components and embedded in the relevant regulatory, social and geographical context of Hong Kong. Critical to the context is the high-rise, high-density, hot-and-humid urban environment of Hong Kong. Policy scenarios are developed for different building types and sectors, supported by a technology roadmap in a progressive manner towards net zero carbon. Stakeholder engagement is an effective mechanism for the formulation and implementation of a ZCB policy.

However, despite recognising the importance of such a ZCB policy for Hong Kong, the majority of the participants perceived limitations to the proposed policy centred on whether the policy targets can be achieved in the proposed timeline, whether zero carbon can ever be achieved for high-rise buildings in Hong Kong, and whether substantial renewable energy can be developed. Debates within the policy scenarios are illustrated in Figure 2, and the future direction could be manifold.

Although a ZCB definition for Hong Kong was proposed, concerns were raised over specific details and the applicability of this definition to different contexts. Taking energy scope as an example, some participants believed embodied energy should be included for 'true' ZCB, others disagreed over whether the energy scope should follow the EMSD scope or include others. These findings echo the differing definitions of ZCB and the like in other countries and regions. For practicality, the proposed definition should have explicit boundaries, particularly in relation to Hong Kong's context, building types and user behaviour.

Regarding the proposed policy targets and timelines, the participants appeared pessimistic and suggesting the timeline was too aggressive. In addition, the lack of a detailed blueprint contributes to policy and business uncertainty. Most participants believed that non-residential buildings could achieve net zero carbon more easily than residential buildings. This finding is in disagreement with the policy priorities for residential buildings in the UK, US, and EU. However, residential buildings in those countries tend to be low-rise and easy to measure, and energy consumption in residential buildings depends on user behaviour while for commercial buildings it is more dependent on energy systems.

Focus group meetings raised a wide range of recommendations regarding renewable energy. Some suggested solar power should be the main focus and it is the most developed energy technology, while others argued that critical learning is needed and that heavy reliance on solar power may not be appropriate for Hong Kong's high density with tens of thousands of high-rise buildings. Some suggested the use of power generation from waste, but shared uncertainties due to the current underdeveloped technologies and client preferences.

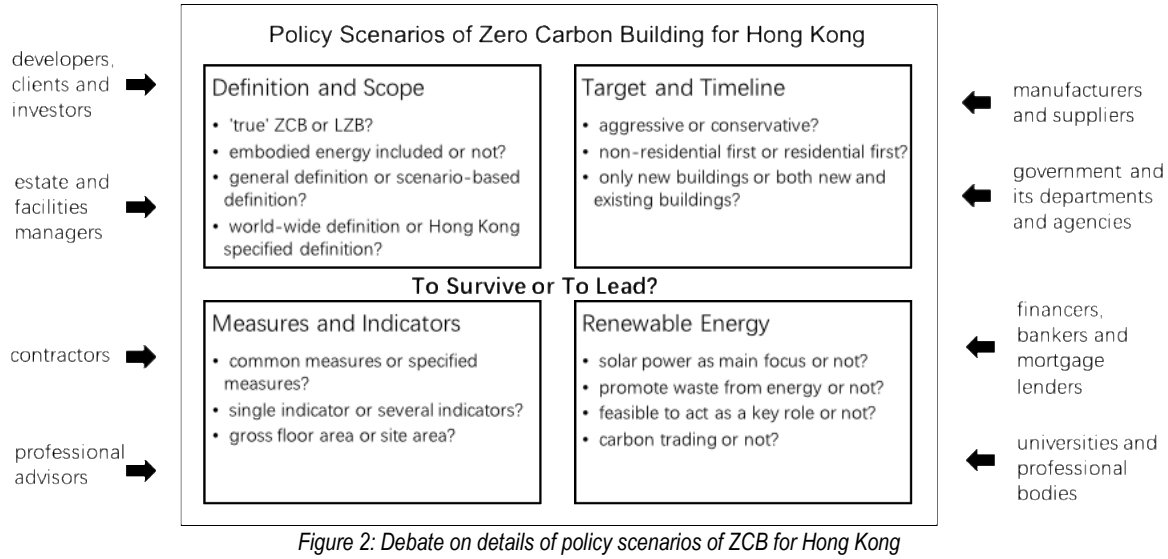

Figure 2: Debate on details of policy scenarios of ZCB for Hong Kong

5. CONCLUSIONS

This paper develops policy scenarios of ZCB for the high-rise context of Hong Kong. A definition of ZCB for Hong Kong is developed and so is a socio-technical systems ZCB policy framework, elaborating four technical components, i.e. definition and scope, measure and indicator, target and timeline, and renewable energy, within their social, regulatory and geographical contexts. Policy scenarios are developed for different building types and sectors from the status quo towards the UN's 2050 carbon neutrality target. Important opportunities are identified for addressing climate change as well as re-shaping energy and infrastructure planning in Hong Kong, whilst significant risks are also discovered with technological constraints and reluctant behavioural changes. The opportunities are found to outperform the risks. To realise the policy scenarios requires the adoption of recommended strategies, aiming a leading model rather than survival. Key to that is to strengthen the partnership between government, industry, universities and communities. To survive or to lead for Hong Kong in the strategic future of high-rise ZCB is not a policy decision per se, but a socio-technical debate provoking an institutional paradigm shift.

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