CONSTRUCTION INDUSTRY COUNCIL
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HONG KONG ZERO CARBON PARTNERSHIP FOR ENHANCING PUBLIC AND STAKEHOLDER ENGAGEMENT

RESEARCH SUMMARY

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Hong Kong Zero Carbon Partnership for Enhancing Public and Stakeholder Engagement
Research Summary

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FOREWORD

The Construction Industry Council (CIC) established the Zero Carbon Building (ZCB) in 2012 as an exhibition, education and information centre for low/zero carbon building design and technology as well as low carbon living. While there is lack of public and stakeholder engagement in the delivery ZCBs, the CIC initiated the research by engaging a research team from The University of Hong Kong to encourage more stakeholders to engage for ZCBs.

The research work presented in this report was funded by the CIC Research Fund, which was set up in September 2012 to provide financial support to research institutes/construction industry organizations to undertake research projects which can benefit the Hong Kong construction industry through practical application of the research outcomes. CIC believes that research and innovation are of great importance to the sustainable development of the Hong Kong construction industry. Hence, CIC is committed to working closely with industry stakeholders to drive innovation and initiate practical research projects.

The research work described in the report was carried out by a research team led by Dr Wei PAN from The University of Hong Kong. The project cannot succeed without the dedicated effort of the research team. I would like to thank to all who took part in this valuable work.

Ir Albert CHENG
Executive Director
Construction Industry Council

PREFACE

To reach carbon neutrality is a primary goal of the Paris Agreement. Aligned with the many Parties, Hong Kong has devised its climate change strategy and set ambitious target for carbon reductions. Buildings worldwide account for over one third of energy consumption and carbon emissions, and therefore stand out as the biggest contributor to anthropogenic climate change. Buildings in Hong Kong consume 92% of electricity and contribute 60% of carbon emissions in the city. Therefore, while buildings present a severe challenge, they also provide an appealing opportunity for carbon reductions. Hence, to explore innovations and solutions for achieving zero carbon is an agenda both significant and imperative for Hong Kong.

The recently published Hong Kong Energy Saving Plan 2015-2015+ advocates a partnership among government, public sector and private sector to collaborate with energy and built environment stakeholders. Also, the Hong Kong's Climate Action Plan 2030+ suggests a voluntary '4T' ('Together, Target, Timeline and Transparency') partnership framework between government and building sector. Indeed, zero carbon buildings (ZCBs) have been considered as not only technological solutions, but also complex socio-technical systems. Their success relies on proactive public and stakeholder engagement in the planning and delivery of buildings.

This project is timely and important to address the partnership of wide stakeholders for ZCBs. Guided by an ambitious aim and a robust plan, the project has established the Hong Kong Zero Carbon Partnership, developed the Hong Kong Zero Carbon Portal, created a database of measuring and monitoring Hong Kong public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCBs, organised four public and stakeholder engagement workshops and four learning and sharing seminars, and published relevant reports and proceedings. The project and the outcomes bring significant benefits for the industry and society, which include: strategically positioning Hong Kong in the international picture of exploring carbon neutrality, effectively enabling the development of a Hong Kong model and solution for zero carbon strategy for buildings in high-rise high-density subtropical climates, systematically enhancing Hong Kong professionals and stakeholders' knowledge and practices of reducing buildings' energy consumption and carbon emissions, and thus strengthening their competitiveness in professional services, and proactively facilitating the Hong Kong building industry's innovation and business transformation for low and zero carbon buildings.

Motivated by the Paris Agreement and the global climate change, there is a strong need to enhance Hong Kong's reputation in green and sustainable building innovation. No doubt the Hong Kong Zero Carbon Partnership will continue contributing to the low carbon economy and smart city development of Hong Kong. The proposed strategic follow-ups of this project on integrating zero carbon with smart technology, business model, stakeholder engagement, policy, and standards are well accomplished with profound implications for achieving a sustainable future of Hong Kong. On all these achievements, I congratulate the project team under the leadership of Dr Wei Pan for completing this important study and exploring its strategic follow-ups for the betterment of industry and society.

Ir Professor Francis T. K. AU
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RESEARCH HIGHLIGHTS

Background and overview

The Paris Agreement pledges to reach 'carbon neutrality' in the second half of the 21st century and calls upon the Parties to cooperate with the private sector, civil society, financial institutions, cities and regions. In Hong Kong (HK), the recently published Energy Saving Plan 2015-2015+ advocates a partnership among government and public sector, private sector to collaborate with energy and built environment stakeholders. The HK's Climate Actin Plan 2030+ suggests a '4T' ('Together, Target, Timeline and Transparency') partnership framework between government and building sector. The 'zero carbon building' (ZCB) approach has been adopted in many countries as an important government climate change strategy, while ZCBs are far more than technological solutions, but complex socio-technical systems. It is therefore important to enhance public and stakeholder engagement in the planning and delivery of ZCBs.

This project has established the Hong Kong Zero Carbon Partnership, developed the Hong Kong Zero Carbon Portal, created a database of measuring and monitoring HK public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCB, organised four public and stakeholder engagement workshops and four learning and sharing seminars, and published relevant reports and proceedings for maximised industry awareness of and engagement with building towards zero carbon.

The Hong Kong Zero Carbon Partnership

The established Partnership aims to function as a mechanism to bridge the links between the public and many stakeholder groups in HK and beyond, and provide a platform to support the transition of the buildings and the built environment in HK towards zero carbon and sustainability. Drawing on systems thinking the Partnership engages the public and stakeholders covering the demand, supply, regulation and institution groups of ZCBs. The Partnership had attracted 80 corporate members as of September 2017 from government departments, industry organisations, professional bodies and institutions, etc.

The Hong Kong Zero Carbon Portal

The developed Portal (www.hkzcp.org) is an IT platform and project website, supported by use of mobile APPs, with a real-time on-line system for monitoring public and stakeholders' understanding, attitude and behaviour regarding ZCBs. The Portal not only provides a single entry and unified channel for public and stakeholders to access project information and ZCB knowledge, but supports them to actively engage in and contribute to the project via flexible mechanisms. With the Portal, the participants' inputs and feedbacks are collected in real-time and analysed using business intelligence technologies. The Portal had attracted 40,211 reads and 27,058 visitors as of September 2017, indicating increasing public's awareness of ZCB and growing Partnership's impact on industry and society.

Knowledge, attitude and behaviour about zero carbon buildings in HK

A questionnaire survey was administered with the wide stakeholder groups of building in HK to measure and monitor the public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCB. As of August 2017, over one thousand sampled professionals and stakeholders in the HK building industry were approached to participate in the survey, 232 attempted and 219 completed. The measurement results are displayed on the Portal, supported by mobile APPs for efficient communications. The main findings are:

Public and stakeholders' awareness and understanding of ZCBs

- The strategy "Reduce energy demand by user behavioural changes" was considered the most important for achieving ZCB in HK, followed by the strategies "Reduce energy loss through efficient building fabric", "Improve energy efficiency of M&E systems" and "Improve efficiency in energy production and supply", but the strategies related to "Carbon offsetting and Carbon Capture & Storage" and "renewable energy" were perceived to be much less important.
- There were inconsistent perceptions in the HK building industry of the scope of energy use in defining ZCB, while more participants favoured the coverage of both regulated energy and unregulated energy.
- There was an inconsistent understanding and knowledge of the HK building stakeholders of the use of energy balance unit in defining ZCB, but half of the participants suggested using 'end-use energy' while fewer participants suggested using 'primary energy' or 'delivered energy'.
- The majority of the participants suggested using the indicators "$kWh/m^2/yr$" and "$kgCO_2/m^2/yr$" for evaluating buildings' energy performance and carbon emissions, but there was a lack of knowledge and understanding of the indicators in industry.
- There was a primary understanding of the annual time period for calculating buildings' energy use and carbon emissions and good awareness of adopting the life cycle approach.
- There was a generally good understanding and knowledge of the participants of the importance of reducing operational energy and carbon of buildings in HK to achieve zero carbon.
- The majority of the participants agreed that renewable energy generated on site should be connected with grid to achieve net zero carbon.

- The participants in general did not favour renewable technologies in reducing buildings' energy use and carbon emissions. The three top-ranked renewable energy technologies were "off-site generation", "on-site generation from on-site renewables" and "generation within the building's footprint".

Public and stakeholders' attitudes to and values for ZCBs

- The majority of the participants perceived that HK developers' willingness to deliver buildings towards zero carbon was weak or very weak.
- Nearly half of the participants perceived the influence of zero carbon living to realizing ZCBs to be strong or very strong, which supports the finding of the top-ranked strategy "Reduce energy demand by user behavioural changes" for achieving ZCBs in HK.
- Over two thirds of the participants perceived that the public's awareness of ZCBs in HK to be poor or very poor.
- There was not enough legislation in HK to support the delivery of buildings towards zero carbon, nor high standards for energy efficiency of different products/systems. A progressive approach was suggested for achieving zero carbon for buildings in HK, and it is imperative to enhance the awareness and knowledge of the public and stakeholders about ZCBs.
- The three top-ranked barriers to delivering buildings towards zero carbon in HK were "higher initial cost", "lack of government policy support" and "uncertain long-term economic return".
- The five feasibility aspects of achieving ZCBs in HK were ranked by level of significance as: commercial viability, policy and regulatory compatibility, technical feasibility, socio-cultural preference, and finally supply chain competency, but all aspects were regarded as significant.

Public and stakeholders' behaviours and practices of ZCBs

- Low/zero carbon living style was observed not yet adopted by general public in HK.
- Less than one-third of the participants always or often applied the knowledge of low/zero carbon building technologies in their practices, less than half applied that sometimes, and the rest rarely or never.
- Less than one-third of the participants always or often referred to Buildings Energy Efficiency Ordinance and Building Energy Code (BEC) in their practices, the second one third applied that sometimes, but the rest rarely or never, or were not aware of the BEEO or BEC.

- Less than one out of five participants always or often referred to Practice Note APP 156 (Design and Construction Requirements for Energy Efficiency of Residential Buildings) in their practices, about one quarter referred to that sometimes, but over half rarely or never, or were not aware of the APP.
- Nearly half of the participants considered it feasible to achieve net-zero carbon in high-rise buildings in HK, about one third held a neutral viewpoint, but the remaining regarded it as infeasible.

Public and stakeholder engagement workshops

Four public and stakeholder engagement workshops were organised to ensure the progressive enhancement of the public and stakeholders' understanding of ZCBs. The learning of the principles, practices, policies and priorities of L/ZCB through the workshops helps with the development of strategies for achieving ZCBs. Such strategies cover the aspects of user behaviour, building energy efficiency, on-site renewable energy technologies, and energy production and supply. Each workshop attracted about 50 professionals and researchers. The workshop reports were published and disseminated for maximised industry awareness and engagement.

Learning and sharing seminars

Four learning and sharing seminars were organized to share and disseminate the knowledge of ZCB in relation to the principles, practices, policies and priorities in HK, and internationally as well. The seminars together help HK public and stakeholders understand zero carbon buildings as complex socio-technical systems which embrace product, process and people, and therefore inform and support their attitudes and behaviours for building towards zero carbon. Each seminar attracted around 200 professionals and researchers. The seminar proceedings were published and disseminated for maximised industry awareness and engagement and international reputation and impact.

Strategic follow-ups of the Partnership

There are strong motivations and justifications to maintain HK's reputation in zero carbon innovations and maximize the Partnership's contribution to low carbon economy and smart city development of HK. Five strategic follow-ups of the HKZCP are proposed and validated via workshop discussions, and they are:

1. zero carbon and smart technology;
2. zero carbon and business;
3. zero carbon and stakeholder engagement;
4. zero carbon and policy; and
5. zero carbon and certification and standards.

These strategic follow-ups should bring significant benefits in social, environmental and economic dimensions. An initial three-year business plan is proposed for sustaining the Partnership and the Portal and for implementing the strategic follow-ups.

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1 INTRODUCTION

1.1 Background

Climate change represents a serious global risk (Stern 2007). In response, there has been a worldwide transition towards a low carbon economy. The Paris Agreement calls for global actions to achieve 'peak' greenhouse gas (GHG) emissions as soon as possible and to reach 'carbon neutrality' in the second half of the 21st century (UNFCCC 2015). To achieve these ambitious targets and mobilise stronger and more ambitious climate actions in the world, the Paris Agreement calls upon the Parties to cooperate with the private sector, civil society, financial institutions, cities and regions.

Buildings worldwide account for over one third energy consumption and carbon emissions (Butler 2008), and act as the biggest contributor to the anthropogenic climate change. With buildings identified with the most opportunity for reducing carbon emissions (IPCC 2007), the Zero Carbon Building (ZCB) approach has emerged as an innovative model of sustainable development of the built environment. The ZCB model has accordingly been adopted in many countries and regions as an important government strategy for addressing climate change, achieving a low carbon economy and uplifting quality of people's life (Wilford and Ramos 2009; Pan and Garmston 2012). Examples include the Energy Performance in Buildings Directive recast for all new buildings in EU countries to be 'nearly zero-energy' by 2020 (EU 2010) and US government's goals of 'net zero energy' for all new commercial buildings by 2030 (Crawley *et al.* 2009). However, despite the strong policy and regulation promotion, there is yet a lack of uptake of the zero carbon approach in practice. ZCBs are often addressed solely based on technological and environmental solutions, whilst their social, cultural and political contexts are overlooked. There is a stern lack of public and stakeholder engagement in the delivery of ZCBs.

Hong Kong (HK) is a subtropical high-density city, with a service-based economy but no energy-intensive industries. According to the HKSAR government (EPD and EMSD 2010), buildings in HK consume 89% of electricity and account for 60% of GHG emissions, which are much larger shares than the worldwide averages. The Energy Saving Plan published by the HKSAR government (ENVB, DEVB and THB 2015) in May 2015 sets for HK to achieve energy intensity reduction by 40% by 2025 using 2005 as the base, and calls for partnership among government and public sector development agencies, private sector to collaborate with energy and built environment stakeholders to enable the 'Energy Wise' transformation. The HK's Climate Action Plan 2030+ (ENVB 2017) in January 2017 set an ambitious carbon intensity target of 65% to 70% by 2030 using 2005 as the base, which is equivalent to 26% to 36% absolute reduction and a reduction to 3.3-3.8 tonnes on a per capita basis. In this

Climate Action Plan, the HKSAR government calls for a voluntary '4T' (that stands for 'Together, Target, Timeline and Transparency') partnership framework between government and building sector to reduce electricity consumption. The Construction Industry Council (CIC) has constructed the first ZCB in HK in 2012, as a signature project to showcase state-of-the-art green design and technologies to the construction industry and raise community awareness of sustainable living (CIC 2012). The CIC ZCB leads and inspires the delivery of buildings in HK towards zero carbon. However, there exist significant challenges and uncertainties with the delivery of high-rise high-density buildings in the HK's subtropical climate, which also requires significant energy for cooling and dehumidification compared with most ZCB practices worldwide with a focus on heating. Motivated by the initiatives in both government and industry domains, it is imperative to systematically enhance public and stakeholder engagement in the transition of HK buildings towards zero carbon.

1.2 Aims and Objectives

This project aimed to help position HK as a world-class knowledge-based, innovation-driven and multi-stakeholder-engaged hub for zero carbon building (ZCB) in urban environments. Five project objectives guided this research:

1. To enhance HK public and stakeholders' awareness and understanding of ZCBs with regard to the concept, practices and policies in HK and worldwide, and their associated challenges and opportunities;
2. To measure, examine and shape HK public and stakeholders' attitudes to and values for ZCB, to reinforce the long-term interests of sustainable development in HK construction industry;
3. To encourage and guide HK public and stakeholders' behaviours and practices of supporting, engaging with and delivering ZCBs in HK;
4. To establish and maintain a 'Hong Kong Zero Carbon Partnership' that consists of the public and stakeholders covering the demand, supply, regulation and institution groups of ZCBs;
5. To develop and maintain a 'Hong Kong Zero Carbon Partnership Portal', which is an IT platform and project website, with a real-time on-line system for monitoring public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCBs.

1.3 Scope

This project was completed by a project team led by Dr Wei Pan of The University of Hong Kong (HKU) with support from the CIC Research Fund during the 30-month period from 01 January 2015 to 30 June 2017. The study was completed with the following scope.

- The Partnership had attracted 80 corporate members as of September 2017. These corporate members, albeit being still a small number of entities in HK, well cover the demand, supply, regulation and institution sides of building in HK and thus provide a reasonable representation of the building stakeholders.
- The Portal and its APPs were developed and has been maintained more with the purpose to disseminate information and knowledge and to measure and monitor public and stakeholders' understanding, attitudes and behaviours with regard to ZCBs. However, the functions of allowing users to upload information are limited, which can be expanded in the future.
- It is out of the scope of this study to develop a technical definition and calculation methodology of ZCB, which were addressed in a recent study completed by a project team led by Dr Wei Pan of HKU with support from the CIC Research Fund on the feasibility of delivering high-rise low or zero carbon buildings in HK and anther recent study by Dr Wei Pan of HKU with support from the Public Policy Research funding by the then Central Policy Unit of the HKSAR Government on the challenges, opportunities and strategies for developing a ZCB policy for HK.

2 RESEARCH METHODOLOGY

2.1 Overall Project Design

The project was carried out through adopting 'systems theories' (Skyttner 2005) to address ZCBs as complex socio-technical systems (Li and Yao 2012) of the combination of products, processes and people involving the demand, supply, regulation and institution groups (Pan 2013), as well as the 'action research' approach to lead to improved knowledge, attitude and behaviour (Koshy 2005). The project effectiveness was ensured using a set of measures and targets (Table 1) derived from the five project objectives.

Table 1 Project effectiveness measures and targets

Objective	Measures	Targets
1	• Number of participants per event and overall; • Level of awareness, understanding and knowledge measured & reported throughout the project;	• 5000 participants (overall); • Project reports (4 workshop reports, 4 seminar proceedings, progress and final project reports); • Improved public and stakeholder awareness, understanding and knowledge of ZCB;
2	• Number of participants per event and overall; • Number of reports and publications; • Attitudes and values measured throughout the project; • Number of downloads of reports from Project Website;	• 5000 participants (overall); • Project reports; • Enhanced public & stakeholder attitudes & values for ZCB; • Good take-up of project reports;
3	• Number of participants per event and overall; • Number of reports and publications; • Behaviours and practices measured throughout the project; • Number of downloads of reports from Project Website;	• 5000 participants (overall); • Project reports; • Informed public and stakeholder behaviours and practices; • Good take-up of project reports;
4	• The Partnership; • Number of participants in the Partnership;	• The Hong Kong Zero Carbon Partnership; • Good public and stakeholder engagement; • 100 partners (both individuals and organisations) in the Partnership;
5	• The Portal; • Number of participants in the Portal;	• The Hong Kong Zero Carbon Partnership Portal;

2.2 Project Package 1: Project Mobilization and International Benchmarking

This project package aimed to help position HK public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCB in the international context, which should facilitate learning and sharing and help to raise the profile of HK in ZCB. The international context reviewed was focused on those urban environments relevant to HK.

The public and stakeholders' awareness, understanding and knowledge of ZCB were measured and monitored throughout the project using questionnaire surveys. The participants in the survey were selected using the 'stratified sampling' strategy to cover the four ZCB stakeholder groups, supported by the membership database of the supporting organisations and relevant trade and professional bodies and public and consumer societies. A copy of the questionnaire is provided in Appendix I. The questionnaire includes: a set of 'Likert Scale' questions and statements to measure public and stakeholders' understanding and perceptions; and a number of open-ended questions to invite participants' elaborations on their understanding and perceptions, and their insights and recommendations for enhancement.

2.3 Project Package 2: Partnership Launch and Operation

The Hong Kong Zero Carbon Partnership (HKZCP) was planned to include public and stakeholders covering the demand, supply, regulation and institution groups of both buildings and the process of building. The Partnership aims to function as a mechanism to bridge the links between the public and many stakeholder groups in HK and beyond, and provide a platform to support the transition of the buildings and the built environment in HK towards zero carbon and sustainability.

The Partnership was launched at the first seminar on 06 January 2015. There were nine founding members of the Partnership, namely, HKU, HKU CICID, CIC, CIC ZCB, Hong Kong Housing Authority, Hong Kong Green Building Council, China Trend Building Press, Pennsylvania State University, and Zero Carbon Hub. As of September 2017, the Partnership attracted 80 corporate members from government departments, industry organisations, institutions, professional bodies, universities etc. Through the corporate members the Partnership further engages a wide range of general public and stakeholders.

The Partnership has been proactively sustained through the HKU project team with support from CIC and wide-ranging stakeholder groups locally in HK and internationally. The project meetings guided the planning and design of the Partnership operation to achieve most effective public and stakeholder engagement for ZCBs in HK.

2.4 Project Package 3: Portal and On-Line Measuring and Monitoring

Supporting the Partnership is the Hong Kong Zero Carbon Portal. The Portal is an IT platform and project website, which not only provides a single entry and unified channel for public and stakeholders to access project information (e.g. news, workshop events, research reports) and ZCB knowledge (e.g. standards, best practices and technologies, and policies), but supports them to actively engage in and contribute to the project via flexible mechanisms (e.g. on-line survey or training programme, web community, social networks and mobile applications). The following specific activities were conducted:

1. Set up and maintained the Portal for sharing ZCB information, guidance, case studies, project reports, web-cast, etc. The Portal was designed according to Model-View-Controller framework, and implemented with mature software architecture and popular programming languages.

2. Established the real-time on-line functions within the Portal to measure and monitor HK public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCB; a questionnaire survey was administered with the results instantly analysed and presented on the Portal.

3. Created categorized discussion board on the Portal for public and stakeholders to interact and share information, concerns and recommendations on ZCB, to embrace two-way communications;

4. Enabled smart phone interactions on the Portal (mobile APPs with IOS system), to encourage greater instant engagement by the public and stakeholders with the Partnership and the Portal.

5. Provided options of contact by mail, email and fax in the Portal to encourage wide public engagement.

2.5 Project Package 4: Public and Stakeholder Engagement Workshops

Four public and stakeholder engagement workshops were organised. The workshop series are an important part of the research initiative, on which the Partnership is based. The workshops were organized in alignment with the seminar series to ensure the progressively enhancement of the public and stakeholders' understanding of ZCBs. The workshops thus mainly targeted the public and stakeholders within HK, focusing on the four key aspects of ZCB: principles, practices, policies and priorities. The learning of the principles, practices, policies and priorities of ZCBs through the workshops helped with the development of strategies for achieving ZCBs, e.g. around the aspects of user behaviour, building energy, and energy production and supply. The workshop reports were published and have been mounted on the Portal for wide access.

2.6 Project Package 5: Learning and Sharing Seminars

Four learning and sharing seminars were organized. The seminar series are another important part of the Partnership. The seminars aimed to share and disseminate the knowledge of ZCB in relation to the principles, practices, policies and priorities in HK and internationally. The seminars together helped HK public and stakeholders to better understand zero carbon buildings as complex socio-technical systems which embrace product, process and people, and therefore inform and support their attitudes and behaviours for building towards zero carbon. The seminars also helped to reinforce the learning and sharing achieved through the workshops and accumulated through the project. Each seminar included learning and sharing of ZCB knowledge and practice from the international context, which were delivered by internationally renowned academics or professionals in the relevant field.

3 RESEARCH FINDINGS AND DISCUSSION

3.1 Partnership Launch and Operation

The HKZCP was launched in January 2015 to enhance the public and stakeholder engagement in delivering ZCBs (see Pan, Li and Lin 2015). Since then the Partnership has proactively engaged public and cross-sector stakeholders for ZCB knowledge sharing and dissemination (see Pan, Lin and Lee 2015; Pan and Lin 2016b). Drawing on systems thinking to maximise the benefits of ZCBs for the society, the Partnership (Figure 1) engages stakeholders in the following four groups to address the socio-technical systems of delivering ZCBs in the geographical, socio-economic, and political and regulatory contexts.

- the 'demand' group, e.g. the general public, building occupants and end-users, clients, investors and buyers, and also the government;
- the 'supply' group, e.g. developers, professional advisors (e.g. architects, designers, engineers, planners, surveyors), contractors, facilities managers, building manufacturers/suppliers, and energy producers and suppliers;
- the 'regulation' group, e.g. the government and its departments and agencies; and
- the 'institution' group, e.g. financers, bankers, mortgage lenders, universities, and professional bodies.

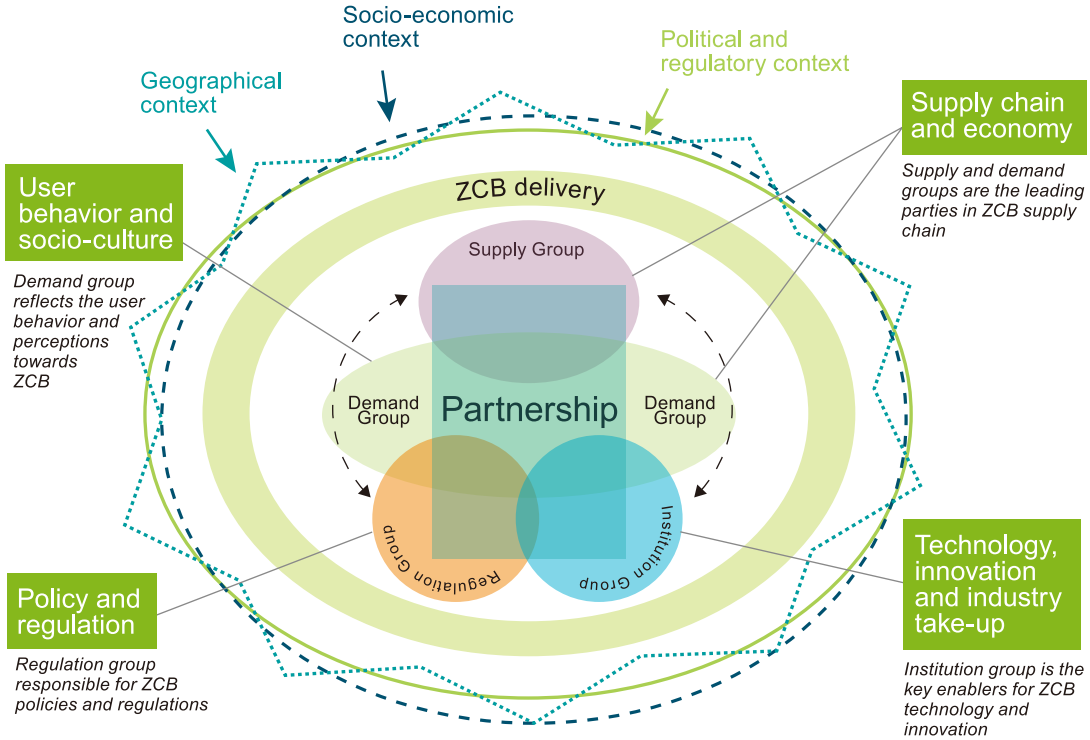

Figure 1 A DSRI stakeholder partnership model of delivering zero carbon buildings (Pan and Pan, 2020a)

Note: DSRI stands for demand, supply, regulation, and institution stakeholder groups.

The Partnership attracted 80 corporate members as of September 2017 from the four stakeholder groups. The Partnership has been well operated through regular project team and committee meetings, four stakeholder workshops and four public seminars.

A full list of the corporate members is presented in the Acknowledgements Section of this report and can also be found on the Portal (at http://www.hkzcp.org/about-us/founding-organizations-and-members/). A world map illustrating the members as of September 2017 is provided in Figure 2.

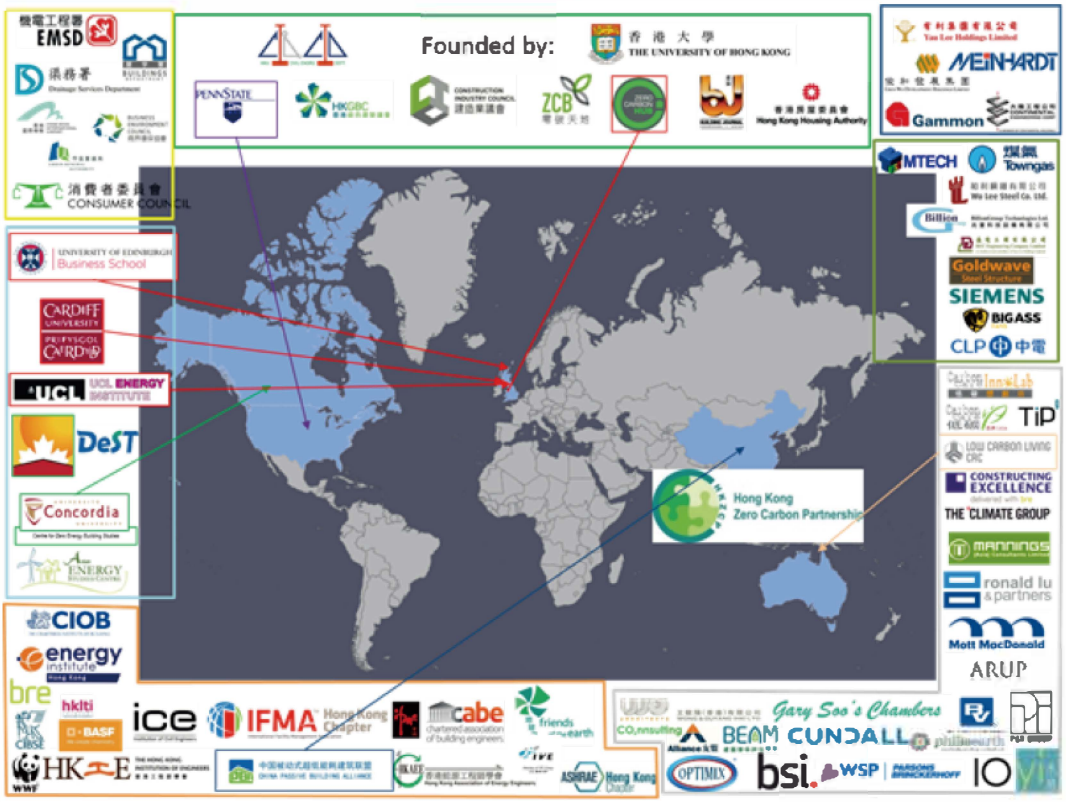

Figure 2 A world map of HKZCP corporate members (as of September 2017)

3.2 Portal Development and Operation

3.2.1 Portal Functions and Statistics

The HKZCP Portal (The Portal) provides a platform to share knowledge of and experience in reducing buildings' energy use and carbon emissions. The Portal aims to help the Partnership to become a world-class knowledge-based, innovation-driven and multi-stakeholder-engaged hub for low or zero carbon building (Figure 3).

To support effective knowledge sharing and practical guidance with regard to ZCB, the Portal was developed and has been maintained with the following main functions:

1. Information and knowledge sharing: project information (e.g. news, workshop events, research reports) and ZCB knowledge (e.g. standards, best practices and technologies, and policies) are provided on the Portal for public access.

2. On-line questionnaire survey and real-time results update: the on-line questionnaire survey has been administered and mounted on the Portal, and the results of the survey are instantly analysed, generated and presented on the Portal to achieve real-time measurement and monitoring.

3. Interactive functions: the Portal provides a range of interactive functions for public and stakeholders to interact and share information, concerns and recommendations, including categorized discussion boards, smart phone interactions, contact channels, etc.

4. The map viewer of corporate members of the Partnership: in both forms of HK and world, is designed to facilitate a better understanding of and collaboration between the corporate members.

Figure 3 Home Page of the HKZCP Portal www.hkzcp.org

The functions above are accessible at the following web links:

- HKZCP home page: http://www.hkzcp.org/
- HKZCP events: http://www.hkzcp.org/category/events/
- HKZCP publications: http://www.hkzcp.org/publications/reports/
- HKZCP knowledge centre: http://www.hkzcp.org/zcb-knowledge-centre/
- Questionnaire survey: http://hkzcp.org/questionnaire/
- Questionnaire real-time report: http://hkzcp.org/report/
- The map viewer (HK): http://hkzcp.org/world_map/hong.php
- The map viewer (World): http://hkzcp.org/world_map/

The Portal attracted increasing awareness of the public of ZCB and imposed a growing impact of HKZCP on industry and society, with 40,211 reads and 27,058 visitors as of September 6, 2017.

3.2.2 Algorithms and Coding for Portal Development

The HKZCP Portal is hosted by GoDaddy, a largest cloud platform for website hosting, which provides full secured domain and hosting and offers the backup facility chronologically. The operation of the Portal is managed by WordPress as one of the most popular content management systems designed in PHP language. WordPress plugins are utilized or customized to realize several functions of the Portal, such as statistical portal records, photo gallery, live chat and comments, etc.

The HKZCP member database is managed and maintained in MySQL database. Structure Query Language (SQL) was utilized to insert, update and fetch the records. The database table schema includes bio-data of members.

To facilitate the management of the members in a more visualized way, the map viewer was developed. Google maps API was used to show the members and their addresses using PHP to fetch the records from database. An algorithm was written in JavaScript that facilitates the google maps API to render the marker on map which demonstrates the addresses and other attributes. SQL was used to filter the records and to query the database using PHP. Hyper Test Markup Language, Cascading Style Sheet, jQuery and angularJS were used in combination for the front-end development. By using AngularJS, some of directives were created to make the front-end development dynamic. In addition, routing functionality was handled by the structure JavaScript framework.

3.2.3 Questionnaire survey design

1. **Front-end development for on-line questionnaire survey**
   Materialize CSS is a user interface component framework which provides reusable, well-tested and accessible UI components, which are attractive, user friendly, and widely used in the interface development. This incredible featured framework was used for building questionnaire web application.

2. **Server side development for on-line questionnaire survey**
   Server side development aims to contact the user interface input, by which the user inputs are fetched and stored into the database, which is a critical portion of web application development. PHP, a well-renowned server side scripting language in back-end development, was used to contact with user interface inputs and database. Secured authentication algorithm was used to provide security of data.

3. **Database management and queries**
   The third tier is to store the user inputs, while two important parts are database selection and design of schema. In general, a lot of databases are designed such as MySQL, PostgresSQL, Oracle etc., with their own features and perspectives. Considering that MySQL database is more widely applied for the web development purpose, it was used to store and manage the data. Schema is the data structure which influences the data management. In our development for on-line questionnaire survey, schema was defined in a dynamic way to store, update and fetch records, which helped to query in a same manner no matter we have millions of records or only hundreds of records. The reliability and robustness of our questionnaire survey web application was therefore guaranteed.

3.2.4 APPs development

Mobile APPs were developed in IOS and Android operating systems to facilitate the public engagement with the Portal. Objective-C is the language to develop IOS APP, and X-Code platform was used. Third party library was used to render graphical information in form of charts and external JSON request was applied to render the data to fulfil the requirement of charts. As for Android one, android-studio was used to develop the APP.

3.3 Questionnaire Survey

A questionnaire survey was administered with the wide stakeholder groups of building in HK to measure and monitor the public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCB, based on the proposed KAP model for ZCBs (Figure 4). The model centres upon stakeholders and highlights the KAP dimensions as ontology, axiology, and epistemology of ZCBs, as complicated systems embedded within socio-technical contexts.

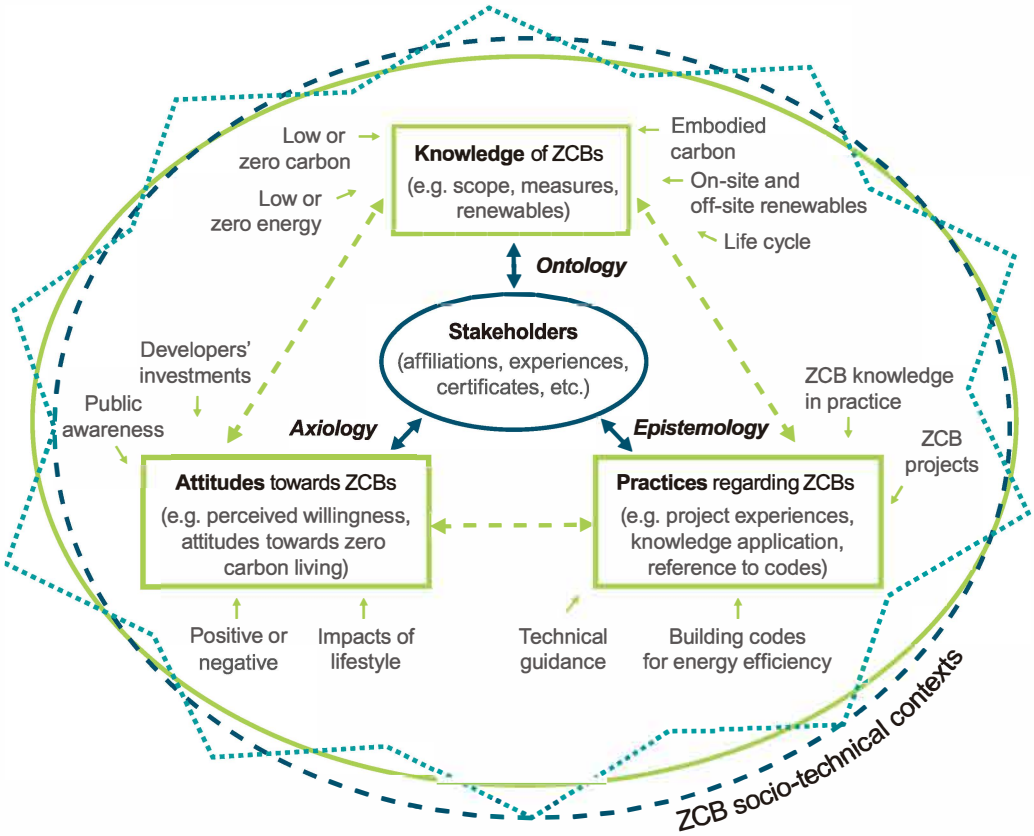

Figure 4 A knowledge, attitude and practice (KAP) model for ZCBs (Pan and Pan, 2020b)

The on-line questionnaire survey was administered and mounted on the Portal (http://hkzcp.org/questionnaire/). The real-time descriptive analyses of the survey results were generated and presented on the Portal (http://hkzcp.org/report/) to achieve the real-time measurement and monitoring. As of August 2017, over one thousand sampled professionals and stakeholders in the HK building industry were invited to participate in the questionnaire survey, 232 attempted and 219 provided effective and valid responses.

3.3.1 Participants in the Questionnaire

The participants who completed the 219 valid questionnaires well covered a wide range of defined stakeholder groups in the HK construction industry. They consisted of engineer (32.4%), contractor (14.2%), surveyors (12.8%), research and education bodies (11.9%), developer (7.3%), architect (4.1%), energy consultant (4.1%), government (4.1%), manufacturer and supplier (2.3%), and others (6.8%) (Figure 5). Some participants covered multiple areas of practice, but only their primary area was considered in this analysis.

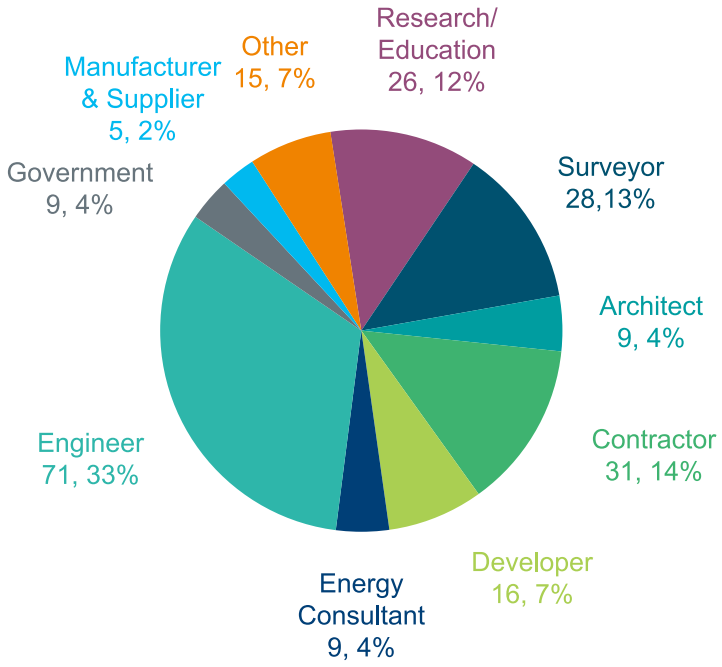

Figure 5 Primary area of practice of the participants (n=219)

As shown in Table 2, nearly 60% of the participants (n=219) had 10 years or more working experiences in the HK building industry. However, the participants' experiences with low or zero carbon building were quite limited, with 72.6% holding no relevant certificate and 47.7% having no project experience with low or zero carbon building. These results fit well with the general profile that the zero carbon concept was quite new in HK.

Table 2 Experiences with building and low/zero carbon building

Criteria	Number	Valid percentage
Number of years of experience in HK building sector (n=219)		
0-5	70	32.0%
6-9	20	9.1%
10-19	41	18.7%
20+	88	40.2%
Certificated green building professional (n=219)		
Beam Pro	37	16.9%
Lead AP	7	3.2%
Others	16	7.3%
No	159	72.6%
Number of BEAM Plus registered or LEED registered building projects involved (n=214)		
0	102	47.7%
1	37	17.3%
2-4	44	20.6%
5+	36	14.5%

3.3.2 Understanding and Knowledge of Zero Carbon Buildings

The participants were asked about their perceived importance of ten proposed strategies for achieving ZCB in HK. A 5-point Likert Scale was used for the measurement, consisting of 'Not important' as 0, 'Of little importance' as 1, 'Somewhat important' as 2, 'Important' as 3, and 'Very important' as 4 (Table 3). The strategy "Reduce energy demand by user behavioural changes" (mean value of 3.442) was considered the most important, followed by the strategies "Reduce energy loss through efficient building fabric" (mean value of 3.367), "Improve energy efficiency of M&E systems" (3.323) and "Improve efficiency in energy production and supply" (3.077). However, the strategies related to "Carbon offsetting and Carbon Capture & Storage" (2.457) and "renewable energy" were perceived to be much less important.

Table 3 Perceived importance of strategies for achieving ZCB in HK (n=219)

Strategy for achieving ZCB in HK	Mean	Rank
(a) On-site renewable energy generation;	2.692	8
(b) Off-site renewable energy generation, but directly connected to the building;	2.701	7
(c) Accredited renewable energy, i.e. contributed to but not directly connected to the building;	2.462	9
(d) Carbon offsetting and Carbon Capture & Storage (CCS);	2.457	10
(e) Reduce energy demand by user behavioural changes;	3.442	1
(f) Reduce energy loss through efficient building fabric;	3.367	2
(g) Improve energy efficiency of M&E systems;	3.323	3
(h) Improve energy efficiency of white goods;	2.993	5
(i) Reduce energy loss in transmission;	2.946	6
(j) Improve efficiency in energy production and supply.	3.077	4

Notes:
Calculations are based on a 5-point Likert scale consisting of 'Not important' as 0, 'Of little importance' as 1, 'Somewhat important' as 2, 'Important' as 3, 'Very important' as 4.

A series of questions were asked in the survey in terms of how to define and measure the ZCB in HK.

First was about the statement that "The energy rating calculation for buildings towards zero carbon in HK should only include regulated energy (space heating, cooling, ventilation, etc.), but not unregulated energy (cooking, washing and electronic appliances)". About 34.8% of the participants agreed or strongly agreed, but 43.4% disagreed or strongly disagreed, leaving 21.9% holding a neutral position (Figure 6). This profile suggests unclear perception in the HK building industry of the scope of energy use in defining ZCB, albeit such profile favouring the coverage of both regulated and unregulated energy.

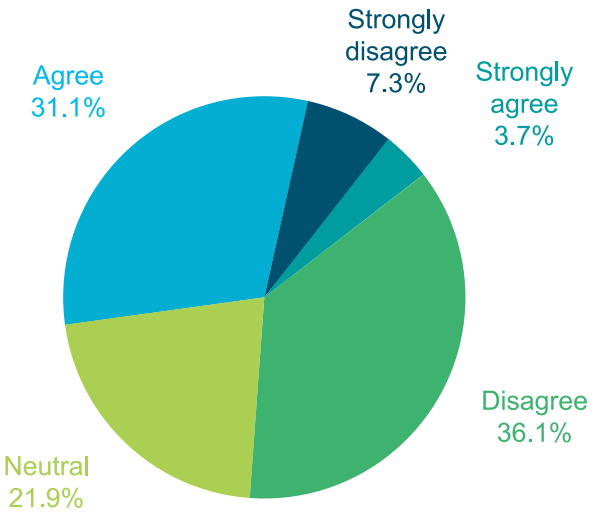

Figure 6 How would you agree on the statement: "The energy rating calculation for buildings towards zero carbon in HK should only include regulated energy (space heating, cooling, ventilation, etc.), but not unregulated energy (cooking, washing and electronic appliances)" (n=219)

Second was about the use of unit of energy balance. Nearly half (49.3%) of the participants suggested using 'end-use energy' to measure building energy use and carbon emissions, followed by 21% being not sure, 16.4% considering to use 'primary energy' and 13.2% arguing for the use of 'delivered energy' (Figure 7). Again, this profile implies inconsistent understanding and knowledge of the HK building stakeholders of the use of energy balance unit.

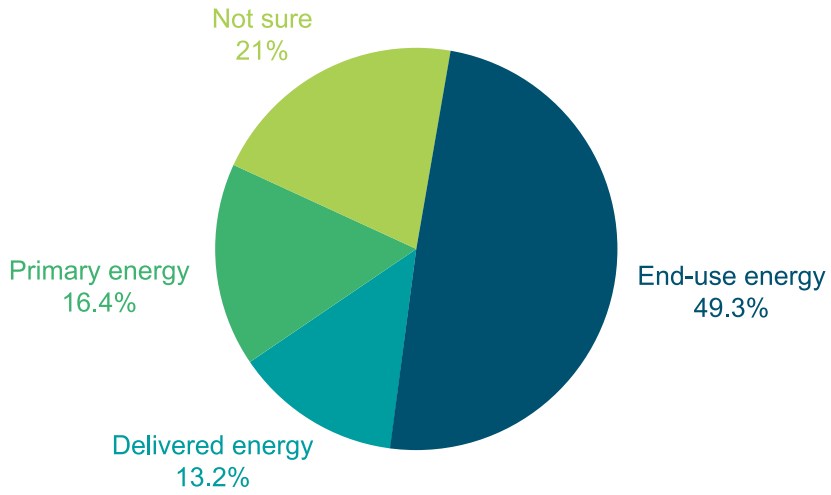

Figure 7 Which unit of energy balance should be used for measuring buildings' energy use and carbon emissions (n=219)

Third was about the use of indicators for evaluating buildings' energy performance. Over 60% of the participants agreed to use the indicators "kWh/m^2/yr" (74, 33.8%) and "kgCO_2/m^2/yr" (58, 26.5%), while the shares of the participants who suggested to use the other three indicators were minimal (Figure 8). However, there were a large proportion of the participants (81, 37%) were not sure, suggesting a lack of knowledge and understanding of the indicators for building energy performance evaluation.

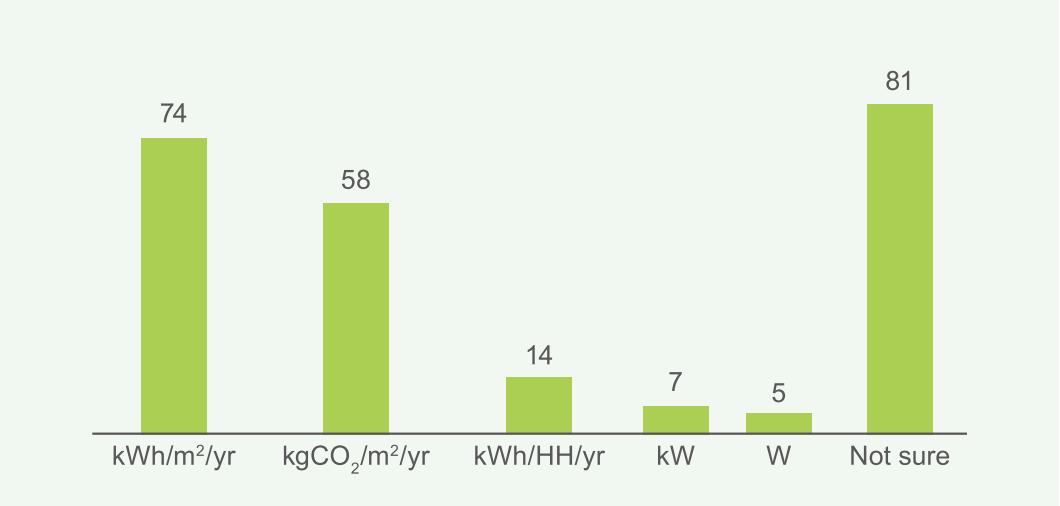

Figure 8 Which indicator(s) shall be used for evaluating building energy performance (n=219)

Fourth was about the time period for calculating buildings' energy use and carbon emissions. The period "annually" (74, 34.1%) and "life cycle" (61, 28.1%) were considered the most suitable options, followed by the period "seasonally" (41) and "monthly" (33). Only a small proportion of the participants (8) were not sure (Figure 9). These results suggest a primary understanding of the annual time period for calculating buildings' energy use and carbon emissions and good awareness of adopting the life cycle approach. The suggestion of seasonal and monthly time period was possibly attributed to specific research purposes.

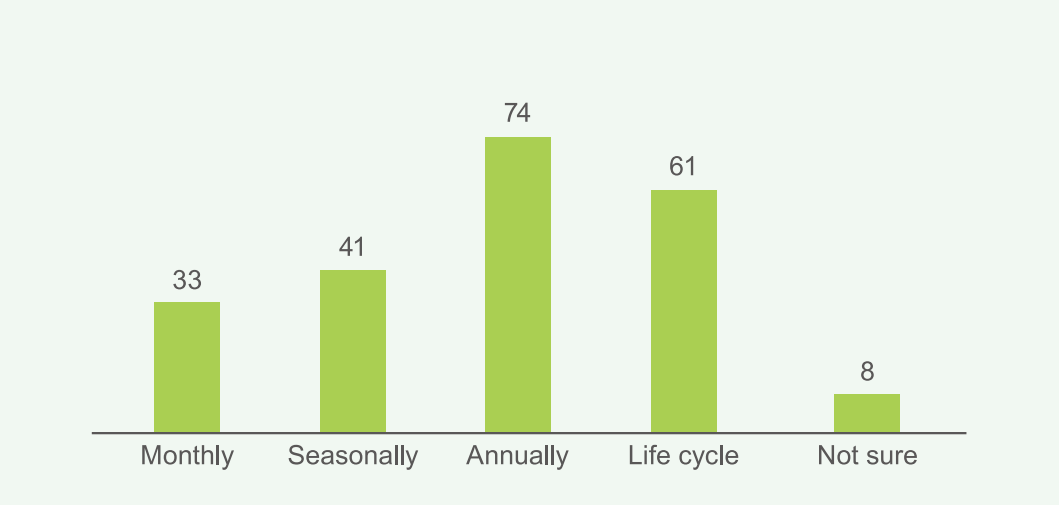

Figure 9 Which time period shall be adopted for calculating building energy use and carbon emissions (n=217)

Fifth was about the statement: "Although it is useful to adopt the life cycle approach to reducing carbon emissions, for achieving 'zero carbon', it is necessary to focus on the operation stage of the building"? Most of the participants (72.2%) agreed or strongly agreed on this statement, with 16.9% holding a neutral position and only 11% disagreed or strongly disagreed (Figure 10). These results are in good alignment with the fact that the operation of buildings in HK contributes to a major proportion (about 90%) of electricity generated in the city. The results suggest a general good understanding and knowledge of the participants of the relevant context.

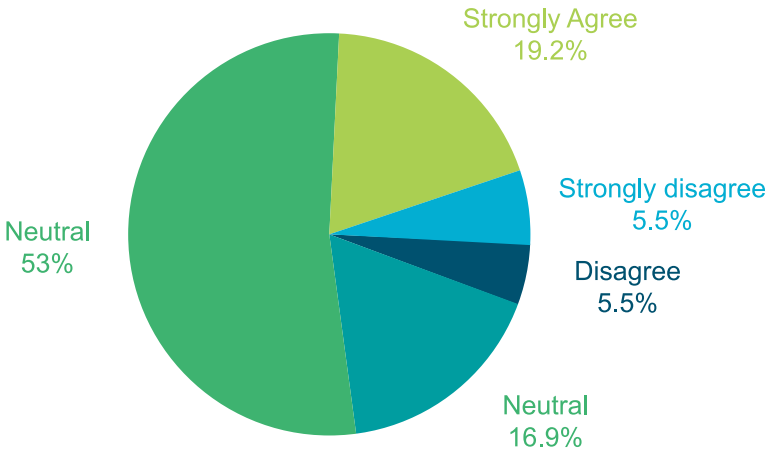

Figure 10 How would you agree on the statement: “Although it is useful to adopt the life cycle approach to reducing carbon emissions, for achieving ‘zero carbon’, it is necessary to focus on the operation stage of the building” (n=219)

Sixth was about if renewable energy generated on site shall be connected with grid. Nearly two-thirds of the participants (62.8%) agreed that renewable energy generated on site should be connected with grid, 26.6% being not sure and 10.6% said disagreed (Figure 11).

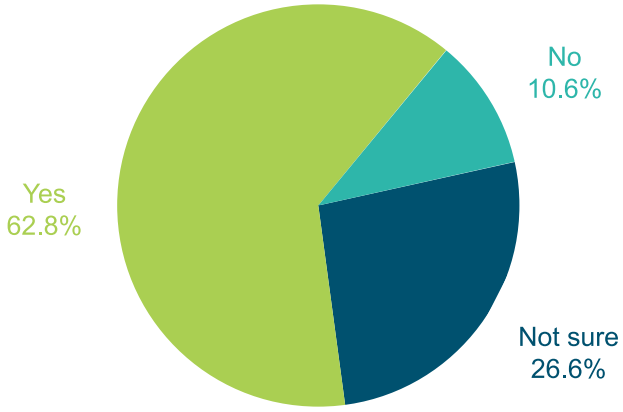

Figure 11 Perspectives on if renewable energy generated on site shall be connected with grid (n=218)

Seventh was about the participants' perspectives on the importance of the proposed options of renewable energy to delivering buildings towards zero carbon in HK. A 5-point Likert Scale was used for the measurement, consisting of 'Not important' as 0, 'Of little importance' as 1, 'Somewhat important' as 2, 'Important' as 3, and 'Very important' as 4 (Table 3). None of the provided options of renewable energy was clearly considered 'important' or 'very important' (with a score of 3 or higher). Instead all options were considered 'somewhat important' towards 'important'. The options "Off-site generation" was top-ranked, followed by "on-site generation from on-site renewables" and "generation within the building's footprint". These results echo the findings early that do not favour renewable technologies in achieving ZCBs in HK (Table 3).

Table 3 Perceived importance of proposed renewable energy to delivering buildings towards zero carbon in HK (n=219)

Proposed renewable energy	Mean	Rank
(a) generation within the building's footprint (e.g. BIPV, roof-mounted PV);	2.645	3
(b) on-site generation from on-site renewables (e.g. on-site solar and wind turbines requiring no source transport);	2.656	2
(c) on-site generation from off-site renewables (e.g. biomass requiring source transport);	2.562	4
(d) off-site generation (i.e. investment in off-site technologies: e.g. wind farm etc.);	2.685	1
(e) off-site supply (purchase of green energy)	2.555	5

3.3.3 Attitude and Value on Zero Carbon Buildings

The majority of the participants (61.4%) perceived that HK developers' willingness to deliver buildings towards zero carbon was weak or very weak, followed by 24.8% of the participants holding a neutral position, while less than one out of seven participants (13.8%) perceived HK developers' willingness to deliver buildings towards zero carbon to be strong or very strong (Figure 12).

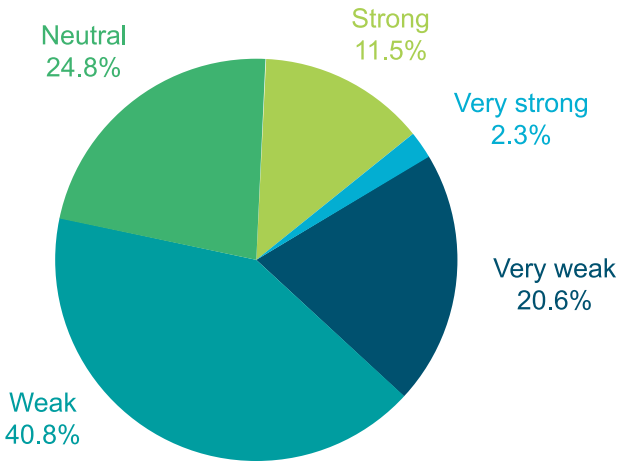

Figure 12 Perceived willingness of HK developers to deliver buildings towards zero carbon (n=218)

About 44.1% of the participants perceived the influence of zero carbon living to realising ZCBs to be strong or very strong, with 25.7% of the participants holding a neutral position and 30.3% regarding that influence to be weak or very weak (Figure 13). This profile favours zero carbon living in realising ZCBs, which supports the finding of the top-ranked strategy "Reduce energy demand by user behavioural changes" for achieving ZCBs in HK (Table 4).

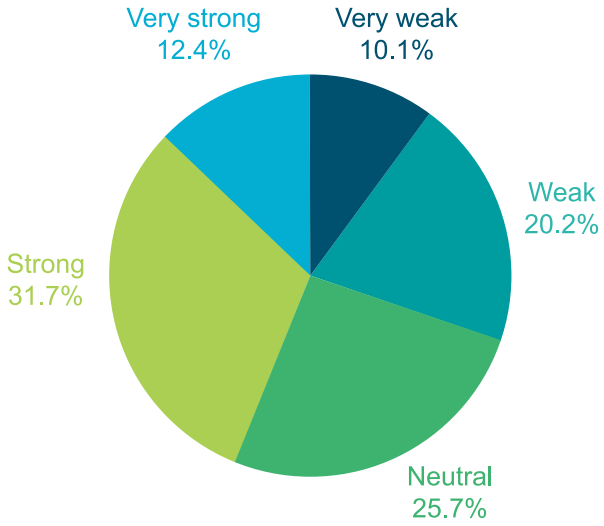

Figure 13 Perceived influence of zero carbon living to realising ZCB (n=218)

Over two-thirds of the participants (68.8%) perceived that the public's awareness of ZCBs in HK to be poor or very poor, followed by 19.7% of the participants holding a neutral position, while less than one out of eight participants (11.5%) perceived the public's awareness of ZCBs in HK to be good or very good (Figure 14).

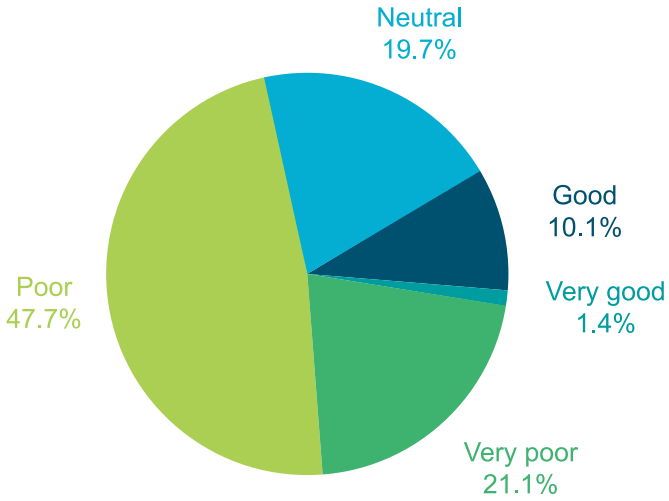

Figure 14 Perceived public's awareness of ZCBs in HK (n=218)

It was highly considered that "There is not enough legislation in HK to support the delivery of buildings towards zero carbon", "HK does not set high standards for energy efficiency of different products/systems". These implied that there are lots of steps before achieving zero carbon buildings in HK from the status quo, and it is imperative to enhance the awareness and knowledge of stakeholders and the public towards ZCBs. Nearly half (49.6%) of the participants agreed with "The realization of buildings towards zero carbon in HK may be hindered by the unique geographic conditions and high-rise high-density urban environment in HK".

Table 4 Attitudes and value in terms of legislation, standards and living style (n=218)

Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
"There is enough legislation in HK to support the delivery of buildings towards zero carbon"	19.3%	52.3%	18.3%	8.3%	1.8%
"HK sets high standards for energy efficiency of different products/systems"	6.9%	40.8%	31.2%	19.3%	1.8%
"The realization of buildings towards zero carbon in HK may be hindered by the unique geographic conditions and high-rise high-density urban environment in HK"	3.2%	22.9%	24.3%	35.8%	13.8%

Notes:
Calculations are based on a 5-point Likert scale consisting of 'Not important or relevant' as 0, 'Of little importance or relevant' as 1, 'Somewhat important or relevant' as 2, 'Important or relevant' as 3, 'Very important or relevant' as 4.

A 5-point Likert Scale was used to measure the participants' attitudes on the significance of a number of potential barriers to delivering buildings towards zero carbon in HK, which consisted of 'Not significant' as 0, 'Of little significance' as 1, 'Somewhat significant' as 2, 'Significant' as 3, and 'Very significant' as 4 (Table 5). None of the provided barriers was clearly considered 'very significant' (with score towards 4). Instead, all barriers were considered 'somewhat significant' or 'significant'. The three top-ranked barriers were "higher initial cost", "lack of government policy support" and "uncertain long-term economic return" (Table 5).

Table 5 Attitudes on the significance of the barriers to delivering buildings towards zero carbon in HK (n=218)

Barriers	Mean	Rank
(a) Lack of customer recognition;	2.761	5
(b) Lack of authoritative energy performance data;	2.644	6
(c) Higher initial cost;	3.237	1
(d) Uncertain long-term economic return;	2.973	3
(e) Lack of government policy support;	3.05	2
(f) Lack of public awareness of zero carbon building	2.857	4
(g) Lack of skilled labour for constructing zero carbon buildings;	2.158	9
(h) Insufficient capacity of suppliers;	2.217	7
(i) Lack of low/zero carbon technologies.	2.186	8

Notes:
Calculations are based on a 5-point Likert scale consisting of 'Not significant' as 0, 'Of little significant' as 1, 'Somewhat significant' as 2, 'Significant' as 3, 'Very significant' as 4.

The same 5-point Likert scale was used to measure the participants' attitudes on the significance of the five feasibility aspects of delivering ZCBs. All five feasibility aspects were regarded as "somewhat significant" or "significant", with the ranking by the level of significance identified to be: "commercial viability", "policy and regulatory compatibility", technical feasibility", "socio-cultural preference", and finally "supply chain competency" (Table 6).

Table 6 Attitudes on the significance of the aspects to asuccessfully delivering ZCBs (n=218)

Aspects	Mean	Rank
(a) technical feasibility;	2.933	3
(b) commercial viability;	3.33	1
(c) socio-cultural preference;	2.84	4
(d) policy and regulatory compatibility;	3.08	2
(e) supply chain competency	2.676	5

Notes:
Calculations are based on a 5-point Likert scale consisting of 'Not significant' as 0, 'Of little significant' as 1, 'Somewhat significant' as 2, 'Significant' as 3, 'Very significant' as 4.

3.3.4 Behaviours and Practices of Zero Carbon Buildings

Respondents were also asked about their own behaviours and practices related to zero carbon buildings.

Low/zero carbon living style was considered poorly adopted in HK. Only 13% of the participants agreed or strongly agreed with the statement that "Low/zero carbon living style is adopted by general public in HK", while 63.4% disagreed or strongly disagreed (Figure 15).

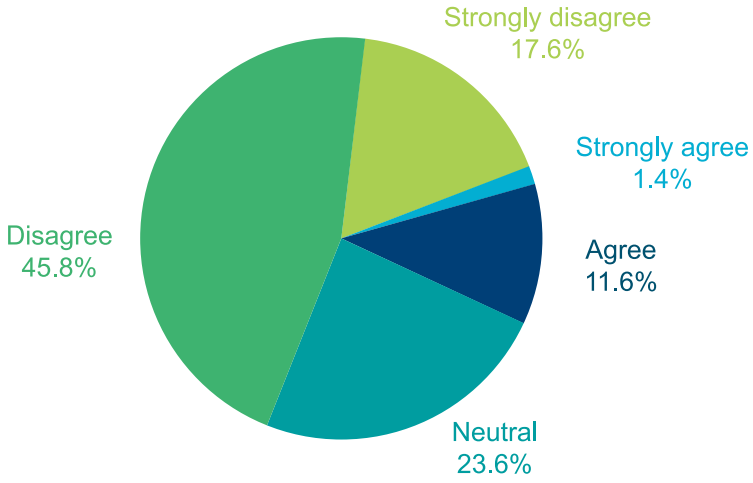

Figure 15 Agreement on the statement: "Low/zero carbon living style is adopted by general public in HK" (n=216)

Only 29% of the participants always or often applied the knowledge of low/zero carbon building technologies in their practices, 47% sometimes, 24% rarely or never (Figure 16).

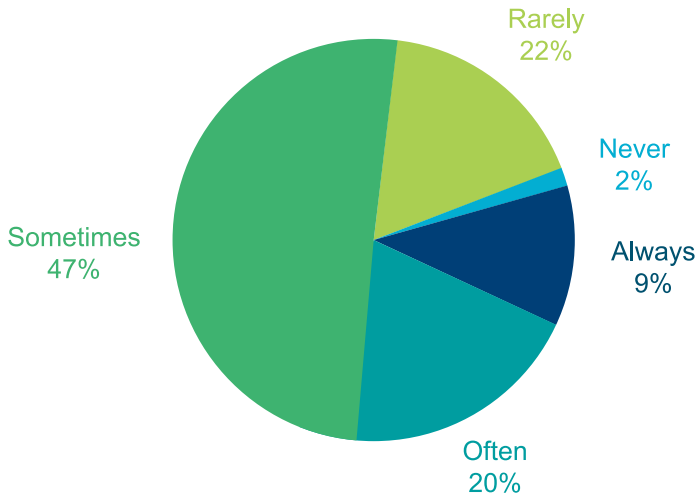

Figure 16 Frequency of applying knowledge of low/zero carbon building technologies in practices (n=213)

More than half of the participants (54.4%) has not been involved in any zero carbon building projects before, 15.8% involved one, 17.7% involved 2-4, 12.1% involved 5 and above (Figure 17).

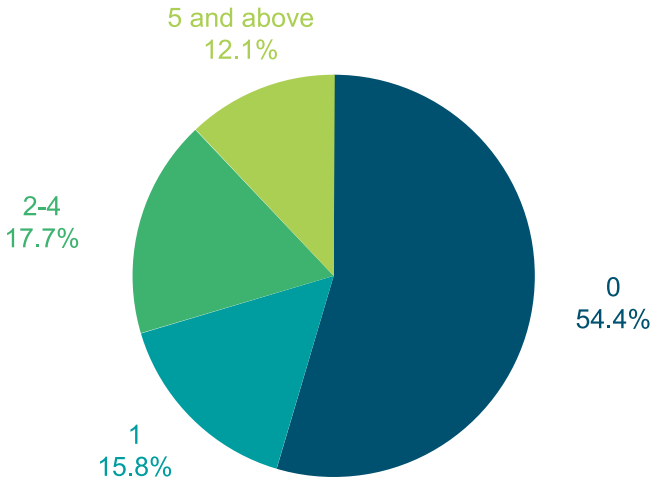

Figure 17 Number of zero carbon building projects the organization of the participants involved (n=215)

Less than one third (31.8%) of the participants always or often referred to Buildings Energy Efficiency Ordinance and Building Energy Code (BEC) in their practices, but 30.9% sometimes and over a one third (37.4%) rarely, never or were not aware (Figure 18).

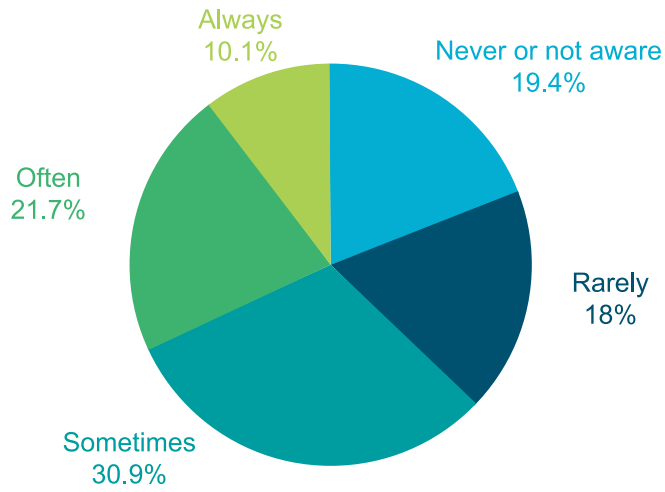

Figure 18 Frequency of referring to Buildings Energy Efficiency Ordinance and Building Energy Code (BEC) 2012 Edition in practices (n=217)

Only 19% of the participants always or often referred to Practice Note APP 156 (Design and Construction Requirements for Energy Efficiency of Residential Buildings) in their practices, but 26% sometimes and over half (55%) rarely, never or were not aware (Figure 19).

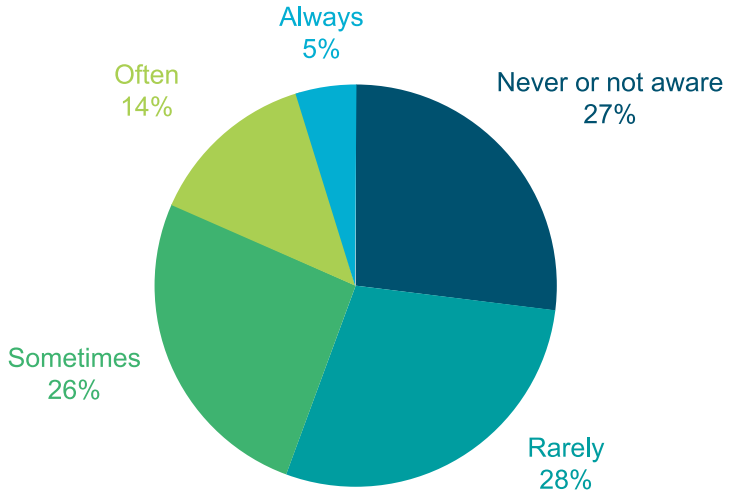

Figure 19 Frequency of referring to Practice Note APP 156 (Design and Construction Requirements for Energy Efficiency of Residential Buildings) in practices (n=217)

In terms of the overall feasibility to achieve net-zero carbon emissions in high-rise buildings in HK, 42% of the participants considered possible, 35% held a neutral viewpoint, but the remaining 22.6% regarded impossible.

3.4 Public and Stakeholder Engagement Workshops

The workshop series were an important part of the research initiative, on which the HKZCP is based. The workshops were organized in alignment with the seminar series to ensure the progressive enhancement of the public and stakeholders' understanding of ZCBs. The workshops mainly targeted the public and stakeholders within HK. The learning of the principles, practices, policies and priorities of L/ZCB through the workshops should help with the development of strategies for achieving ZCBs. Such strategies cover the aspects of user behaviour, building energy efficiency, on-site renewable energy technologies, and energy production and supply.

An overview of the HKZCP workshops is provided in Table 7. Each workshop attracted about 50 professionals and researchers as planned.

Table 7 An overview of the workshops

Date	Venue	Title of the workshop
Oct 16, 2015	HKU	Public and Stakeholder Engagement for Building towards Zero Carbon
Jan 21, 2016	ZCB	Knowledge, Attitude and Behaviour of Zero Carbon Buildings
Dec 14, 2016	HKU	Challenges and Opportunities of Zero Carbon Buildings
Sept 29, 2017	HKU	Partnering for a Zero Carbon Future

All workshop reports were published (Pan, Lin and Wong 2015; Pan, Lin and Ng 2016; Pan, Pan and Yang 2016; Pan and Pan 2017) and can be downloaded from the Portal.

3.5 Learning and Sharing Seminars

The seminar series were another important part of the research initiative, on which the HKZCP is based. The seminars aimed to share and disseminate the knowledge of ZCB in relation to the principles, practices, policies and priorities in HK, and internationally as well. The principles include the elements, parameters, boundaries of ZCBs in a systems manner, and the associated public and stakeholders' perceptions. The practices refer to the challenges, opportunities, good practice and lesson learnt with regard to the planning and delivery of zero carbon buildings. The policies denote the relevant policies, codes and regulations to low or zero carbon building. The priorities mean the strategies for management and benchmarking. The seminars together should help HK public and stakeholders

understand zero carbon buildings as complex socio-technical systems which embrace product, process and people, and therefore inform and support their attitudes and behaviours for building towards zero carbon.

An overview of the HKZCP seminars is provided in Table 8. Each seminar attracted around 200 professionals and researchers as planned.

Table 8 An overview of the seminars

Date	Venue	Title of the workshop
Jan 6, 2015	ZCB	Zero Carbon Buildings: International Practice and Stakeholder Engagement
Oct 16, 2015	HKU	Zero Carbon Buildings: State-of-the-Art International Research and Development
Apr 28, 2016	HKU	Systems Zero Carbon Building: Policy and Partnership
Dec 14, 2016	HKU	Technology and Innovation for Zero Carbon Building

All seminar proceedings were published (Pan *et al.* 2015; Pan, Lin and Lee 2015; Pan and Lin 2016a; Pan, Pan and Yang 2016) and can be downloaded from the Portal.

3.6 Achievement of the Research Objectives

The aim of this project is to help position HK as a world-class knowledge-based, innovation-driven and multi-stakeholder-engaged hub for ZCB in urban environments. The HKZCP has exerted a profound influence on both industry and public for enhanced awareness and understanding of ZCBs through a series of activities and events. The achievement of the five research objectives is discussed below, which provides evidence to demonstrate the successful achievement of the objectives and deliverables.

3.6.1 HK public and stakeholders' awareness and understanding of ZCBs

Objective 1: To enhance HK public and stakeholders' awareness and understanding of ZCBs with regard to the concept, practices and policies in HK and worldwide, and their associated challenges and opportunities

This objective has been achieved mainly through the administered questionnaire survey, Portal engagement by public and stakeholders, and the four organised public and stakeholder workshops. The dissemination of ZCB related information and knowledge through different channels and networks also contributed to that. The comparison between the targets and achievements is provided in Table 9.

Table 9 Objective 1: Targets vs. achievements

Targets (as in proposal)	**Achievements** (as of project completion)
• 5000 participants (overall); • Project reports (4 workshop reports, 4 seminar proceedings, progress and final project reports); • Improved public and stakeholder awareness, understanding and knowledge of ZCB;	• 40,211 reads and 27,058 visitors of the Portal as of Sept 2017; • Over a thousand professionals invited; 232 responded with 219 valid replies; • Project reports (4 workshop reports, 4 seminar proceedings, progress and final project reports); • Level of awareness, understanding and knowledge measured & reported of the project; • Perceived improved public and stakeholder awareness, understanding and knowledge of ZCB;

3.6.2 HK public and stakeholders' attitudes and values on ZCBs

Objective 2: To measure, examine and shape HK public and stakeholders' attitudes to and values for ZCB, to reinforce the long-term interests of sustainable development in HK construction industry

This objective has been achieved mainly through the administered questionnaire survey, Portal engagement by public and stakeholders, and the four organised public and stakeholder workshops. The dissemination of ZCB related information and knowledge through different channels and networks also contributed to that. The comparison between the targets and achievements is provided in Table 10.

Table 10 Objective 2: Targets vs. achievements

Targets (as in proposal)	**Achievements** (as of project completion)
• 5000 participants (overall); • Project reports • Enhanced public & stakeholder attitudes & values for ZCB; • Good take-up of project reports;	• 40,211 reads and 27,058 visitors of the Portal as of Sept 2017; • Over a thousand professionals invited; 232 responded with 219 valid replies; • Project reports (4 workshop reports, 4 seminar proceedings, progress and final project reports); • Level of attitudes and values measured & reported of the project; • Perceived improved public and stakeholder attitudes and values of ZCB;

3.6.3 HK public and stakeholders' behaviours and practices of ZCBs

Objective 3: To encourage and guide Hong Kong public and stakeholders' behaviours and practices of supporting, engaging with and delivering ZCBs in HK

This objective has been achieved mainly through the administered questionnaire survey, Portal engagement by public and stakeholders, and the four organised public and stakeholder workshops. The dissemination of ZCB related information and knowledge through different channels and networks also contributed to that. The comparison between the targets and achievements is provided in Table 11.

Table 11 Objective 2: Targets vs. achievements

Targets (as in proposal)	**Achievements** (as of project completion)
• 5000 participants (overall); • Project reports; • Enhanced public & stakeholder attitudes & values for ZCB; • Good take-up of project reports;	• 40,211 reads and 27,058 visitors of the Portal as of Sept 2017; • Over a thousand professionals invited; 232 responded with 219 valid replies; • Project reports (4 workshop reports, 4 seminar proceedings, progress and final project reports); • Level of attitudes and values measured & reported of the project; • Perceived improved public and stakeholder attitudes and values of ZCB;

3.6.4 Hong Kong Zero Carbon Partnership

Objective 4: To establish and maintain a 'Hong Kong Zero Carbon Partnership' that consists of the public and stakeholders covering the demand, supply, regulation and institution groups of ZCBs

The 'HKZCP' that consists of the public and stakeholders covering the demand, supply, regulation and institution groups of ZCBs has been established. The Partnership has been effectively operated with a series of seminars and workshops, which should help to enhance the public and stakeholders' awareness and understanding of ZCBs with regard to the concept, practices and policies in HK and worldwide, and their associated challenges and opportunities. The comparison between the targets and achievements is provided in Table 12.

Table 12 Objective 4: Targets vs. achievements

Targets (as in proposal)	**Achievements** (as of project completion)
• The Hong Kong Zero Carbon Partnership; • Good public and stakeholder engagement; • 100 partners initially (both individuals and organisations) in the Partnership;	• The Partnership established and proactively sustained; • 80 corporate members attracted to the Partnership with more in the process; • 4 workshops and 4 seminars organised

3.6.5 Hong Kong Zero Carbon Portal

Objective 5: To develop and maintain a 'Hong Kong Zero Carbon Partnership Portal', which is an IT platform and project website, with a real-time on-line system for monitoring public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCBs

The 'HKZCP Portal' has been developed as a multi-functional platform to encourage and guide HK public and stakeholders' behaviours and practices of supporting, engaging with and delivering ZCBs in HK.

The real-time on-line survey has been developed within the portal for monitoring public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCBs, and to measure, examine and shape HK public and stakeholders' attitudes to and values for ZCB. The comparison between the targets and achievements is provided in Table 13.

Table 13 Objective 5: Targets vs. achievements

Targets (as in proposal)	**Achievements** (as of project completion)
• The Hong Kong Zero Carbon Partnership;	• The Portal developed and proactively accessed; • 40,211 reads and 27,058 visitors of the Portal as of Sept 2017; • Mobile APPs provided for IOS system for more efficient communications

3.7 Challenges to Delivering ZCBs in Hong Kong

Challenges to delivering ZCBs in HK were identified in workshop discussions, which further justify the significance of the Partnership. The challenges are summarised below:

- There is no consistent definition and calculation methodology of ZCB for HK, hindering effective measurement and benchmarking.
- There is a poor understanding of the business case or cost performance of ZCBs.
- There is real and perceived technical infeasibility to achieve zero carbon for high-rise high-density buildings in the subtropical climate of HK, clouded by a fragmented use of smart and renewable technologies.
- There is a lack of government regulatory and incentive support for building towards zero carbon in HK particularly for the private sector, with no ZCB policy or roadmap established.
- There is inadequate gearing of general public and stakeholders in their knowledge, attitude and behaviour regarding low or zero carbon.
- There is insufficient and fragmented education of ZCBs among students and professionals.
- More challenges exist with decarbonising existing buildings in HK due to technical and geographical constraints.

3.8 Technology and Innovation for Delivering ZCBs in Hong Kong

Technologies and innovations were also identified during workshop discussions, which should help to address the challenges:

- Innovative and passive design should be promoted to maximize buildings' energy efficiency and minimize energy use intensity.
- Innovative and low-carbon building materials should be strongly recommended to improve buildings' energy and carbon efficiency over the life cycle of the building.
- Innovative and game-changing construction methods and approaches such as modular construction, automation and robotics should be strongly supported to reap the full benefits from manufactured construction in minimized waste, accelerated return on investment, improved health and safety, etc.
- BIM and energy simulation tools and software should be further adopted to facilitate the design process, while relevant training should be improved.
- Smart technologies such as wireless sensors, IoT and monitoring systems should be promoted for improving transparency and accuracy of measuring energy use data for benchmarking and shaping users' behaviours.
- Renewable and emerging technologies such as PV, CCHP and district cooling should be promoted to offset grid electricity demand in order to achieve net zero.

These technologies and innovations, of course, should be coupled with political, regulatory, economic, social strategies for addressing the challenges. Different industry players must learn, communicate, and collaborate with each other for achieving ZCBs in HK in the long term. Therefore, there are strong justifications for the Partnership to sustain and contribute:

- To produce a white or policy paper on ZCB for HK and develop a clear roadmap for that.
- To develop a definition of ZCB for HK addressing the high-rise high-density subtropical context.
- To conduct evidence-based research on the platform of the Partnership to inform government policy and business decision making.
- To further enhance HK public and stakeholders' knowledge (understanding), attitude (value), and behaviour (practice) of ZCB.

4 CONCLUSIONS AND RECOMMENDATIONS

This chapter concludes the project, provides recommendations, and suggests strategic follow-ups of the Partnership with a business plan

4.1 Conclusions

4.1.1 The Hong Kong Zero Carbon Partnership

The established Partnership aims to function as a mechanism to bridge the links between the public and many stakeholder groups in HK and beyond, and provide a platform to support the transition of the buildings and the built environment in HK towards zero carbon and sustainability. Drawing on systems thinking the Partnership engages the public and stakeholders covering the demand, supply, regulation and institution groups of ZCBs. The Partnership attracted 80 corporate members of organisations as of September 2017 from the four stakeholder groups.

4.1.2 The Hong Kong Zero Carbon Portal

The developed Portal is an IT platform and project website, supported by use of mobile APPs, with a real-time on-line system for monitoring public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCBs. The Portal aims to help the Partnership to become a world-class knowledge-based, innovation-driven and multi-stakeholder-engaged hub for low or zero carbon building (L/ZCB). The Portal not only provides a single entry and unified channel for public and stakeholders to access project information (e.g. news, workshop events, research reports) and ZCB knowledge (e.g. standards, best practices and technologies, and policies), but supports them to actively engage in and contribute to the project via flexible mechanisms (e.g. online survey, training programme, web community, social networks and mobile applications). With the Portal, the participants' inputs and feedbacks are collected in real-time and analysed using business intelligence technologies for measuring and monitoring public and stakeholders' understanding, attitudes and behaviours with regard to ZCBs. The Portal attracted increasing public's awareness of ZCB and imposed a growing impact of the Partnership on industry and society, with 40,211 reads and 27,058 visitors recorded as of September 2017.

4.1.3 Knowledge, attitude and behaviour about ZCBs in HK

A questionnaire survey was administered with the wide stakeholder groups of building in HK to measure and monitor the public and stakeholders' understanding (knowledge), attitude (value) and behaviour (practice) regarding ZCB. The survey was conducted using the combination of questionnaires by post, in electronic form, and as an on-line form mounted on the Portal. As of August 2017, over one thousand sampled professionals and stakeholders in the HK building industry were invited to the survey. In total 232 attempted questionnaires were received, among which 219 were effective and valid.

A database of the measurements using the questionnaire survey was developed. Based on this database the measurement results are displayed on the Portal, supported by mobile APPs for efficient communications. The survey, via the online form, is live, and the real-time descriptive analyses of the survey results were generated and presented on the Portal (http://hkzcp.org/report/) to achieve real-time measurement and monitoring.

Findings of HK public and stakeholders' awareness and understanding of ZCBs

- The strategy "Reduce energy demand by user behavioural changes" was considered the most important for achieving ZCB in HK, followed by the strategies "Reduce energy loss through efficient building fabric", "Improve energy efficiency of M&E systems" and "Improve efficiency in energy production and supply", but the strategies related to "Carbon offsetting and Carbon Capture & Storage" and "renewable energy" were perceived to be much less important.
- There were inconsistent perceptions in the HK building industry of the scope of energy use in defining ZCB, while more participants favoured the coverage of both regulated energy (space heating, cooling, ventilation, etc.) and unregulated energy (cooking, washing and electronic appliances).
- There was an inconsistent understanding and knowledge of the HK building stakeholders of the use of energy balance unit in defining ZCB, but half of the participants suggested using 'end-use energy' while fewer participants suggested using 'primary energy' or 'delivered energy'.
- The majority of the participants suggested using the indicators "kWh/m^2/yr" and "$kgCO_2/m^2/yr$" for evaluating buildings' energy performance and carbon emissions, but there was a lack of knowledge and understanding of the indicators in the industry.
- There was a primary understanding of the annual time period for calculating buildings' energy use and carbon emissions and good awareness of adopting the life cycle approach.

- There was a generally good understanding and knowledge of the participants of the importance of reducing operational energy and carbon of buildings in HK to achieve zero carbon.
- The majority of the participants agreed that renewable energy generated on site should be connected with grid to achieve net zero carbon.
- The participants in general did not favour renewable technologies in reducing buildings' energy use and carbon emissions. None of the provided options of renewable energy was clearly considered very important. The three top-ranked renewable energy technologies were "Off-site generation", "on-site generation from on-site renewables" and "generation within the building's footprint".

Findings of HK public and stakeholders' attitudes to and values for ZCB

- The majority of the participants perceived that HK developers' willingness to deliver buildings towards zero carbon was weak or very weak.
- Nearly half of the participants perceived the influence of zero carbon living to realising ZCBs to be strong or very strong, which supports the finding of the top-ranked strategy "Reduce energy demand by user behavioural changes" for achieving ZCBs in HK.
- Over two-thirds of the participants perceived that the public's awareness of ZCBs in HK to be poor or very poor.
- There was not enough legislation in HK to support the delivery of buildings towards zero carbon, nor high standards for energy efficiency of different products/systems. A progressive approach was suggested for achieving zero carbon for buildings in HK, and it is imperative to enhance the awareness and knowledge of public and stakeholders about ZCBs.
- The three top-ranked barriers to delivering buildings towards zero carbon in HK were considered to be "higher initial cost", "lack of government policy support" and "uncertain long-term economic return".
- The five feasibility aspects of achieving ZCBs in HK were ranked by level of significance as: commercial viability, policy and regulatory compatibility, technical feasibility, socio-cultural preference, and finally supply chain competency, but all aspects were regarded as significant.

Findings of HK public and stakeholders' behaviours and practices of ZCBs

- Low/zero carbon living style was observed not yet adopted by general public in HK.
- Less than one-third of the participants always or often applied the knowledge of low/zero carbon building technologies in their practices, less than half applied sometimes, and the rest rarely or never.
- Less than one-third of the participants always or often referred to Buildings Energy Efficiency Ordinance and Building Energy Code (BEC) in their practices, the second one third applied to that sometimes, but the rest rarely or never, or were not aware of the BEEO or BEC.
- Less than one out of five participants always or often referred to Practice Note APP 156 (Design and Construction Requirements for Energy Efficiency of Residential Buildings) in their practices, about one quarter referred to that sometimes, but over half rarely or never, or were not aware of the APP.
- Nearly half of the participants considered it feasible to achieve net-zero carbon in high-rise buildings in HK, about one third held a neutral viewpoint, but the remaining regarded it as infeasible.

4.1.4 Public and stakeholder engagement workshops

Four public and stakeholder engagement workshops were organised, in alignment with the four learning and sharing seminars to ensure the progressive enhancement of the public and stakeholders' understanding of ZCBs. The learning of the principles, practices, policies and priorities of L/ZCB through the workshops helps with the development of strategies for achieving ZCBs. Such strategies cover the aspects of user behaviour, building energy efficiency, on-site renewable energy technologies, and energy production and supply.

Date	Venue	Title of the workshop
Oct 16, 2015	HKU	Public and Stakeholder Engagement for Building towards Zero Carbon
Jan 21, 2016	ZCB	Knowledge, Attitude and Behaviour of Zero Carbon Buildings
Dec 14, 2016	HKU	Challenges and Opportunities of Zero Carbon Buildings
Sept 29, 2017	HKU	Partnering for a Zero Carbon Future

Each workshop attracted about 50 professionals and researchers. The workshop reports were published and disseminated for maximised industry awareness and engagement.

4.1.5 Learning and sharing seminars

The seminars aimed to share and disseminate the knowledge of ZCB in relation to the principles, practices, policies and priorities in HK, and internationally as well. The principles include the elements, parameters, boundaries of ZCBs in a systems manner, and the associated public and stakeholders' perceptions. The practices refer to the challenges, opportunities, good practice and lesson learnt with regard to the planning and delivery of zero carbon buildings. The policies denote the relevant policies, codes and regulations to low or zero carbon building. The priorities mean the strategies for management and benchmarking. The seminars together help HK public and stakeholders understand zero carbon buildings as complex socio-technical systems which embrace product, process and people, and therefore inform and support their attitudes and behaviours for building towards zero carbon.

Date	Venue	Title of the seminar
Jan 6, 2015	ZCB	Zero Carbon Buildings: International Practice and Stakeholder Engagement
Oct 16, 2015	HKU	Zero Carbon Buildings: State-of-the-Art International Research and Development
Apr 28, 2016	HKU	Systems Zero Carbon Building: Policy and Partnership
Dec 14, 2016	HKU	Technology and Innovation for Zero Carbon Building

Each seminar attracted around 200 professionals and researchers. The seminar proceedings were published and disseminated for maximised industry awareness and engagement and international reputation and impact.

4.2 Recommendations

The first three project objectives are to enhance HK public and stakeholders' awareness and understanding of ZCBs; to shape HK public and stakeholders' attitudes to and values for ZCBs; and to guide HK public and stakeholders' behaviours and practices of ZCBs. The other two project objectives are to establish the Partnership and to develop the Portal. While all objectives have been successfully achieved, recommendations are provided in these five aspects for exploring a zero carbon future of buildings in HK.

4.2.1 Enhancing public and stakeholders' awareness and understanding of ZCBs

Recommended is adopting the socio-technical systems approach (Pan 2015; Ning, Pan and Zhao, 2015) coupled with the stakeholder framework (Pan 2013) over a long-term period from now to 2050 from which the Paris Agreement pledges to reach 'carbon neutrality'.

- The HKSAR government in collaboration with CIC has made great efforts to raise the awareness of building toward zero carbon through the CIC ZCB located in Kowloon Bay and other projects, campaigns and research initiatives (including the HKZCP). However, there is still a strong need to raise the general public's awareness of ZCBs and to generate in-depth knowledge of ZCBs (particularly of high-rise buildings) for the industry and professional community.
- Apart from the public sector's initiatives, regulations and incentives, the private sector such as developers, contractors and consultants should be further engaged and encouraged. The Partnership should further engage corporate members in the private sector.
- Education on ZCBs should be tailored to best fit stakeholders from different backgrounds, e.g. students. Developers, policy makers. Education should start from students, supplementing the industry, as young generations will be critical to realising zero carbon in the long term. The government should encourage the relevant parties to run competitions on the themes of ZCB in schools and to organise exhibition events for the public.
- In addition to the CIC ZCB which acts as an education centre for industry and public, universities should hold academic seminars, workshops and events to disseminate ZCB knowledge.
- Media such as newspapers and TV programmes should be considered to introduce and promote ZCB knowledge and benefits.

- The government should consider publishing a ZCB policy paper, to clarify and clearly define the concept and calculation methodology of ZCB for HK to enable consistent understanding. The CIC should consider publishing guidelines on the technical solutions for achieving ZCBs for HK to demonstrate to the public and stakeholders the feasibility and benefits.

4.2.2 Shaping public and stakeholders' attitudes and values for ZCBs

Recommended is the adoption of the political, economic, socio-cultural, technological, environmental and legislative (PESTEL) analytical framework to demonstrate multi-dimensional drivers for and benefits from ZCBs.

- The government should plan and build more ZCBs in HK for education and demonstration purposes, which may cover multiple building types and sectors.
- The government should consider publishing a ZCB policy paper to lead and shape the public and stakeholders' attitudes and values for ZCBs. The government should also consider legislating larger buildings' carbon emission reductions for selected building types and sectors to stimulate the building market.
- Nevertheless, a progressive approach should be adopted in the policy paper and legislation, e.g. to distinguish new-build from retrofit, public from private buildings, residential from commercial, and high-rise from low or medium-rise. This approach should best encourage and engage the industry and community in the long term.
- Buildings' carbon emissions rating, either estimated for new-build or audited for existing by relevant authorities, should be provided by developers/clients in the sales package, in order to shape a low carbon building sales market.
- In educating the general public, the notion of and the financial and health benefits from adopting a low or zero carbon building or lifestyle should be emphasised. Also, the consequences of not adopting a low or zero carbon building or lifestyle should be made clear, in order to better inform the public's decision making.
- Transparency of buildings' energy use and carbon emissions data should be provided to enable evidence to show values for ZCBs.

4.2.3 Guiding public and stakeholders' behaviours and practices of ZCBs

Recommended is the adoption of the 'carrot-and-stick' dual approach and smart technologies as triggers for behavioural changes.

- Policies and regulations play a primary role in raising the demand for ZCBs and provide incentives, so they largely motivate and guide public and stakeholders' behaviours and practices. The government should provide more incentives (and/or tax rebate) to building owners and private developers for adopting L/ZCB technologies and designs.
- The government or CIC should consider publishing step-by-step guidance of best practices for L/ZCB. In this guidance, the life cycle cost approach should be promoted to help quantify the holistic cost benefit of ZCB. A 'L/ZCB Map' of HK can also be produced to showcase the companies specialising or embracing ZCBs.
- The utility companies should consider providing incentives to end-users should they use less energy than average, and on the other hand applying higher tariff to end-users should they use excessive energy; however, this business model should be supported by the government.
- Transparency of and accessibility to energy use data will help to increase building owners or tenants' awareness of excessive energy use and thus inform user behavioural changes.
- Generating renewable energy, in addition to reducing energy consumption, should be provided with incentives in order to achieve net zero carbon. As a start lower cost green technologies with shorter payback period can take priority.
- Smart technology should be encouraged to help shape user energy-efficient behaviours, such as to use smart cards and sensors to alert users of energy inefficient behaviours, and to use smart meters to provide visual access to energy use information.
- Energy audits should be required for not only the common areas of buildings but the residence and tenant areas, so to enable a holistic energy use and carbon emissions picture.

4.2.4 Strategic Follow-ups of the Partnership

The project has imposed significant impact on public and stakeholder engagement for building towards zero carbon in HK. The project has also attracted attention and support from a range of overseas parties and built up a good international reputation of the HK construction industry in zero carbon innovation. We should maintain this international reputation and maximizing its contribution to low carbon economy and smart city development of HK. We should also further explore the Partnership's impact on government policy and industry practice of ZCB for reaping the benefits of ZCBs.

Recommended are five strategic follow-ups of the HKZCP.

1. Zero carbon and smart technology:

    a. To identify smart technologies for measuring and reducing buildings' energy use and carbon emissions. Examples of measuring include smart meters, smart plugs, IoT based sensors for measuring, and examples of reducing include energy-efficient materials and renewable technologies. The measurements should provide evidence to inform policy and business decision making.

    b. To provide a visualization interface on the HK Zero Carbon Portal for clients of buildings to input energy consumption data for blind benchmarking with other relevant energy consumption database. This interface will be supported by 'big data' analytical functions.

2. Zero carbon and business:

    a. To maintain the Partnership on-line questionnaire survey and publish the results on the Portal instantly and dynamically, in order to inform business decisions in terms of the knowledge, attitude and practices of L/ZCB in HK.

    b. To attract more corporate members of the Partnership, particularly from the carbon reduction technology manufacturers and suppliers, to support the establishment of capable L/ZCB supply chains for HK.

    c. To develop a series of cameo case studies of utilizing low/zero carbon building and smart technologies. The case studies will be put on the Portal for business learning and sharing.

    d. To produce guidelines for business to de-risk their adoption of L/ZCBs.

3. Zero carbon and stakeholder engagement:

   a. To organise annual 'zero carbon forum' to facilitate international knowledge sharing and HK-based knowledge transfer and stakeholder engagement, addressing the topics of zero carbon technology, policy, business model.

   b. To contribute one paper each year to the CIC Zero Carbon Building Journal, disseminating findings of the survey and the forum.

   c. To maintain the mobile APPs of the Portal for efficient communications.

   d. To develop and provide short video clips of L/ZCBs on the Portal for more efficient stakeholder engagement.

4. Zero carbon and policy:

   a. To produce a policy paper on zero carbon in HK drawing on the results of the project. This policy paper will develop a HK construction industry roadmap, based on clearly defined scope, to achieve zero carbon for buildings in HK by 2050 in a progressive manner.

   b. Policies, incentives and measures will be recommended in the policy paper.

5. Zero carbon and certification and standards:

   a. To develop recommendations for inclusion in BEAM Plus, which will cover the use of smart technologies and energy use benchmarking.

   b. To develop standards for achieving zero carbon of high-rise high-density buildings in subtropical climates.

   c. To maintain a searchable database as part of the HK Zero Carbon Portal to include worldwide case studies of ZCBs to guide the development of certification and standards.

There will be **significant benefits from these strategic follow-ups**, which include:

- Strategically positioning HK in the international picture of following up the Paris Agreement and achieving the 'carbon neutrality' target.
- Continuously raising the international reputation of the HK construction industry in ZCB innovation.
- Effectively enabling the development of a HK construction industry roadmap to achieve zero carbon for buildings in HK by 2050, setting a HK model of high-rise high-density subtropical buildings towards zero carbon.

- Systematically enhancing HK professionals and stakeholders' knowledge and practices of reducing buildings' energy consumption and carbon emissions, and thus strengthening their competitiveness in professional services in 'Belt and Road' countries.
- Proactively facilitating the HK building industry's L/ZCB innovation and business transformation.
- Creating synergies with the CIC ZCB by the proposed strategic follow-ups for maximized impact on policy influence, evidence collecting and knowledge sharing.
- Maximizing exposure to ZCB knowledge and practice of the public and stakeholders not just in HK but internationally via the Portal and mobile APPs.
- Providing a platform on which to develop major funding and engagement initiatives locally and internationally in strategic alliances with similar parties.

A business plan for implementing the strategic follow-ups is proposed:

- An initial three-year plan is proposed for sustaining the Partnership and the Portal with annual reviews of the progress and achievements.
- The sustained Partnership will be guided by a Partnership Committee, with members from HKU, CICID, CIC, ZCB, and relevant corporate members of the Partnership.
- HKU will be responsible for the administration and coordination for the Partnership and Portal, and also for the implementation of the proposed strategic follow-ups.
- Funding is requested from CIC and/or other relevant sources for sustaining the Partnership and the Portal and implementing the proposed strategic follow-up activities.
- The Partnership itself will then attract matching or top-up resources through donations, events and research initiatives.

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