The first Zero Carbon Building in Hong Kong
Photo: Courtesy of the Construction Industry Council

Zero carbon buildings

Contexts, challenges and strategies

By Dr Wei Pan, The University of Hong Kong

Climate change represents a very serious global risk[1]. In response, there has been a worldwide transition towards a low carbon economy, amongst which the Chinese central government has set a target to reduce carbon intensity by 17% and energy intensity by 16% over the 2011-2015 period[2], and the Hong Kong SAR government has pledged to reduce Hong Kong's carbon intensity by 50-60% on the 2005 baseline by 2020[3]. Buildings worldwide account for as much as 45% of energy consumption and carbon emissions[4], while in Hong Kong, a service-based economy with no energy-intensive industries, buildings consume 89% of electricity, accounting for 60% of greenhouse gas (GHG) emissions[5]. With buildings being identified with the most opportunities for reducing GHG emissions, the zero carbon building (ZCB) approach has been adopted in many countries/regions as an important government climate change strategy[6, 7]. Examples include the UK government's targets to achieve 'zero carbon' for new homes from 2016 and for non-domestic new buildings from 2019[8]; the Energy Performance in Buildings Directive (EPBD) forecast for all new buildings in Europe to be 'nearly zero-energy' by 2020[9]; and US government's goals of net zero energy for all new commercial buildings by 2030[10]. In Hong Kong, the Construction Industry Council (CIC) has constructed the first ZCB in Hong Kong 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. However, although ZCB has emerged as an innovative model of sustainable development in the built environment, its take-up faces significant challenges.

Lack of understanding of ZCB principles

Terms describing ZCB abound in the literature, e.g. zero carbon/emission building, low or zero energy building, green building, sustainable building. However, the understanding of ZCB is fragmented,

with no commonly agreed definition or elaboration of its elements and parameters. Also, no clear boundaries of ZCBs have been set. Critical debate exists on the focus on regulated, user-related and/or embodied carbon/energy and their association with the building lifecycle.

Insufficient and inconsistent ZCB practices

ZCBs are often regarded as solely green or zero carbon products delivered by the supply side, or as merely the extension of government climate change policy into the building sector. Although there is increasing building energy research interest in user behaviour, little knowledge is known of the relationships and interactions between the supply, demand, regulation and institution sides of ZCBs. Few attempts exist to explore how the public and stakeholders can work in partnership to achieve ZCBs and secure long-term interests of sustainable development.

Unclear and uncertain ZCB policies

Very few countries/regions have set their ZCB policies, most regarding it as part of their climate change policy or building energy codes and regulations. The UK is the first country to set a timetable for delivering ZCBs. However, the definition and policy of ZCB, since its announcement in 2006, have encountered serious debate. A key point of the debate is the scope of the energy with which carbon emissions are associated, i.e. from the original proposed 'complete' zero carbon (including both regulated, i.e. for space heating, ventilation, lighting and hot water; and unregulated energy, i.e. for cooking, washing and electronic entertainment appliances[11]) to 'regulated' energy only[12]. Another point of the debate is the three-tier hierarchy of measures to achieving zero carbon, i.e. 'energy efficiency', 'carbon compliance', and 'allowable solutions'[13], with allowable solutions being criticised for its fundamental weakness[14].

Conflicting ZCB priorities

There is no explicit link known between achieving zero carbon and improving environmental sustainability. This denotes that a highly scored 'sustainable' building might not all achieve zero carbon, and vice versa, a ZCB may not score high at all in its overall environmental sustainability. A ZCB or a 'sustainable' building may not prove to be economically or socially sustainable, which is actually evidenced in the literature[15] and also perceived by the stakeholders in general[16]. It is worth noting that buildings globally, in addition to being the major contributor to anthropogenic climate change, also account for 20% of water use and 30-40% of solid waste generation, use 32% of the world's resources and directly employ over 111 million people in the world[17].

All these challenges, albeit being severe, are manageable. Strategies can be developed around the '4P' elements of ZCB, i.e. principles, practices, policies and priorities.

- Systems approaches should be adopted to understand ZCB principles. The conventional understanding of ZCBs with an overspecialisation on carbon/energy needs to be expanded to cover the other environmental parameters and social and economic concerns. ZCBs are complex socio-technical systems, not only green or zero carbon 'products', but innovative 'processes' for integration, as well as 'people' for better communication and engagement with the public and stakeholders throughout the building lifecycle.
- Good ZCB practices should be captured for learning in the wide context. The boundaries of ZCBs should be explicitly identified and defined to enable effective learning and benchmarking.
- ZCB policies of a country/region should be established in close relation with the relevant climate change and energy policies and building energy codes and regulations.
- ZCB priorities should be identified and managed within the context of concern, in alignment with the relevant ZCB principles, practices and policies.

To successfully implementing these strategies partnership should be established among the public and stakeholders. Such partnership will need to be as far-reaching as possible in the industry as well as in the society in order to maximise synergies between different interest groups and impacts on people's thinking, behaviour and practice. Four key groups of the public and stakeholders should be included: 1) the demand side, e.g. the general public, building

occupants and end-users, clients, investors and buyers, and also government; 2) the supply side, e.g. developers, professional advisors (e.g. architects, designers, engineers, planners, surveyors), contractors, facilities managers, building manufacturers/suppliers, and energy producers and suppliers; 3) the regulation side, e.g. government and its departments and agencies; and 4) the institution side, e.g. financers, bankers, mortgage lenders, universities, and professional bodies. Only through a joint force of the whole society ZCBs can be delivered in alignment with the triple bottom line of sustainable development in the long term.

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[1] Stern, N. (2007) The Economics of Climate Change: The Stern Review, HM Treasury, London.

[2] China's National Economic and Social Development 12th Five-Year Plan (2011-2015), http://www.gov.cn/2011lh/content_1825838.htm.

[3] Chief Executive (2010) Sharing Prosperity for a Caring Society, 2010-11 Policy Address, The HKSAR Government, Hong Kong.

[4] Butler, D. (2008) Architects of a low-energy future. Nature, 452(3), 520-23.

[5] Environmental Protection Department and Electrical and Mechanical Services Department (2010) Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong, Hong Kong.

[6] Wilford, C. and Ramos, M. (2009) Zero Carbon Compendium: Who's Doing What in Housing Worldwide, NHBC Foundation, Amersham.

[7] Pan, W. and Garmston, H. (2012) Compliance with Building Energy Regulations for New-Build Dwellings. Energy, 48(1), 11-22.

[8] DCLG (2006) Building a Greener Future: Towards Zero Carbon Development: Consultation, Department for Communities and Local Government (DCLG), London.

[9] EU (2010) Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast). Official Journal of the European Union.

[10] Crawley, D., Pless, S. and Torcellini, P. (2009) Getting to net zero. ASHRAE Journal, 51(9), 18–25.

[11] Same as no.8.

[12] HM Treasury (2011) The Plan for Growth, HM Treasury, London.

[13] DCLG (2008) Definition of Zero Carbon Homes and Non-Domestic Buildings: Consultation, DCLG, London.

[14] McLeod, R.S., Hopfe, C.J. and Rezgui, Y. (2012) An investigation into recent proposals for a revised definition of zero carbon homes in the UK. Energy Policy, 46, 25-35.

[15] HM Government (2010) Low Carbon Construction Innovation & Growth Team Final Report, Department for Business, Innovation and Skills, London; ZCH, 2011. Carbon Compliance: Setting an appropriate limit for zero carbon new homes – findings and recommendations. Zero Carbon Hub (ZCH), London.

[16] NHBC Foundation (2008) Zero carbon: what does it mean to homeowners and housebuilders? Amersham. NHBC Foundation.

[17] United Nations Environment Programme (UNEP) (2012) Building and Construction, http://www.unep.fr/scp/bc/.