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Delivering Zero Carbon Buildings: The Role of Innovative Business Models

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Abstract

Zero carbon building (ZCB) has emerged as an innovative approach to improving building energy performance and reducing building carbon emissions. However, the uptake of the ZCB approach is slow, far from the mainstream practice of building. Previous studies have devoted to analyze the technical feasibility and design issues of ZCB. Some have examined the barriers to the adoption of ZCB practices in the market, social, regulatory and/or financial aspects. However, few have explored the role of business models in the delivery of buildings towards zero carbon. The aim of this paper is thus to examine the effect of business model on ZCB, and to explore innovative business models that can stimulate the uptake of ZCB. The paper first reviews the concepts of ZCB and identifies the challenges to ZCB based on the PESTEL analytical framework. The paper then investigates the conceptual framework of business models for ZCB. Nine key elements of the business model are identified, which include offering, target customer, distribution channel, customer interfaces, resource and core competency, partner network, cost and revenue model. Evidence is collected to substantiate the arguments through case study with one recent ZCB project selected from varied contexts. The results of the case study presented an innovative business model that helps address the challenges to delivering ZCB. The research findings help to demonstrate to practitioners the business potential of ZCB and to guide how innovative business models can help accelerate the uptake of the ZCB approach.

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1. Introduction

The construction industry imposes significant environmental and social impacts. Globally, buildings account for more than 40% of total primary energy use and 24% of greenhouse gas emissions [1, 2]. In addition, the other negative impacts of construction activities such as resources consumption and waste production and disposal are also well recognized [1]. As an unprecedented force, sustainable development has been reshaping the construction industry since the late 1980's, changing the physical structures and working principles of the organizations, and impelling professionals engaged in all phases of building process rethink their roles in the building delivery process [2]. As an interchangeable term with green or high performance building, sustainable building is built in a resource-efficient manner based on ecological principles and life cycle consideration, with the aim of minimizing environmental impacts and enhancing health issues [2, 3]. In recent years, ZCB has emerged as an innovative approach to reduce negative effects of the building sector. Several countries have set regulatory targets for ZCB. For instance, the UK set ambitious target for the all new homes to be zero carbon from 2016 and to reduce carbon emissions by at least 80% over the 1990 baseline by 2050 [4]. Energy Performance of Buildings Directive (EPBD) of the European Parliament and of the Council specified that by December 2020 all new buildings to be “nearly zero energy” [5]. The US Department of Energy (DOE) set the target of achieving zero energy homes by 2020 and zero energy commercial buildings by 2025 [6].

Numerous studies have been conducted to present the benefits of ZCB [7-9]. Research also has been conducted to provide design and technical solutions for ZCB. Wang et al. [10] compared the possible design strategies for ZCB under Cardiff climate condition. Koch et al. [11] evaluated ZCB at a neighborhood scale and redefined the energy balance of buildings from both the demand and supply side. Despite the literature on the benefits and technical solutions of ZCB, a number of studies have demonstrated the difficulties of implementing ZCB by examining the challenges resided in the building development process. Pan and Maxey [12] examined the challenges to delivering ZCB from the PESTEL analytical framework. Glass et al. [13] identified the barriers of developing ZCB from technological, legislative, economic and social aspect. The reported barriers to ZCB include high up-front cost, limited access to financing, and uncertainty market.

Owing to the challenges faced by ZCB, currently ZCBs only contribute to a very small proposition of the construction market in both developed and developing countries. The industry to date has recorded a limited number of ZCBs with verifiable energy performance data [14]. However, few have examined the uptake of ZCB from the business perspective. The effect of the business strategy on the delivery of ZCB is still vague. Targeting at such knowledge gap, this paper proposed a novel approach to addressing ZCB from the perspective of business model. This paper aims to develop the analytical framework of business model for ZCB and identify innovative business models for successful ZCB delivery. The paper first reviews the concept boundary and challenges to ZCB. It then develops the conceptual framework of business model in relation to ZCB. It finally explored the innovative business model for the delivery of ZCB is explored through a case study with a recent completed ZCB project.

By reviewing the existing calculation metrics within the ZCB definitions, the paper proposed a systems dimensional framework for the definition of ZCB and extracted the features of reviewed definitions. The study also explores the challenges faced by ZCB based on the PESTEL analytical framework. The paper then develops the conceptual framework of business model for ZCB through combining the literature from the management discipline and sustainable construction sector. The case study is applied to explore the innovative business model for ZCB. The case organization is a federal organization which has long term dedicated to renewable energy and energy efficient technologies research and practices. The ZCB project delivered by the case organization will be examined. The resources for case study include the publications regarding the case project, websites, reports and publications on the case organization' mission and business strategies regarding L/ZCB.

2. ZCB: terminology and challenges

2.1. ZCB: terminology and theory

ZCB is an emerging hot research topic in recent years. However, no consensus has been reached on the definition and concept boundaries of ZCB. A multiple of approaches have been employed to define ZCB. A series of terms

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