Barriers to Zero Energy Construction (ZEC)

Technically possible; why not succeed yet?

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ABSTRACT: The construction activities have a significant impact on the environment in terms of energy consumption and use of raw materials. The construction industry has been challenged to meet the human needs in environmentally friendly ways. Environmentally friendly measures and proven renewable energy generating technologies are developed. The problem realizing zero energy construction using the state of the art technologies is only to minor extent a technical one. Barriers of managerial nature are still impeding a broad adoption of zero energy constructions.
Keywords: zero energy construction, project management, barriers, construction industry, sustainable construction, energy, environmental management.

INTRODUCTION

Constructing is not by nature an environmentally friendly activity [1]. It is widely accepted that construction activities, including the construction, maintenance and use of the built projects, have large impacts on the environment in terms of environmental pollutions, air, waste, noise and water. The construction of buildings in the UK consumes about 40% of the national primary energy consumption and about 25% of raw material use is attributed to it [2]. Thus, the role of the construction industry to improve the environment, or at less to diminish its impact on it, is becoming a very important one. The challenge to the construction industry is to meet the growing human needs for facilities for living, working in an environmentally friendly way [3].

Sustainable construction In 1987, the commission of Bruntland has defined sustainable development as "development which meets the needs of the present without compromising the ability of future generations to meet their needs" [4]. Generally, sustainable construction is seen by some authors as a way for the construction industry to contribute to the effort to achieve sustainable development [5]. Initiatives to define an acceptable common definition of 'sustainable construction' have not succeeded yet [5]. Kibert [6] defined sustainable construction as 'the creation and responsible management of a healthy built environment based on resources-efficient, ecologically-based principles'. Wyatt [7] defined it from a 'cradle to grave' perspective including managing the functionality of a building during the whole life cycle. Hill and Bowen [8] presented sustainable construction as consisting of four attributes; social, economic, biophysical and technical supported by a set of over-arching, process-oriented principles. All of 'sustainable construction' definitions acknowledge that achieving high levels of sustainability is possible, but construction would continue to have environmental impacts [5].

Zero energy construction ZEC is a sustainable construction with high level of energy saving. ZEC can be defined in several ways depending on the ZEC goal. The demand-side of supply strategies, the values applied by the design team and type of building owner affect the goal and subsequently the definition of ZEC [9]. The U.S. Department of Energy (DOE) Building Technologies Program defines a net zero energy building as a residential or commercial building with greatly reduced needs for energy through efficiency gains, with the balance of energy needs supplied by locally renewable technologies [10]. In this paper ZEC is a sustainable construction with very high level of energy saving. It is perceived as a net-connected, normal, perform well, comfortable and require only standard maintenance construction using state-of-the-art, highly energy-efficient designs and applying on-site proven renewable energy generation technologies to generate as much energy as it takes on an annual basis.

The first initiatives of ZEC have been taken early in the last century. These initiatives have proved that ZEC was technically possible at that time [11]. Achieving the a ZEC has a three-steps approach; 1) reducing the energy demand through employing high degree of thermal insulation, air tightness building envelope, heat recovering from ventilation air, using energy efficient appliances and avoid standby losses, 2) the energy demand will be then met by locally generated renewable energy such as wind, biomass and solar energy, and 3) in

the case of lack of renewable energy sources, energy from the utility grid may be taken.

ZEC could be an important element for reducing energy consumption and improving the environment, it helps builders to enhance their image and to differentiate in the market and for the buyers a comfortable home with predictable and stable monthly housing costs [10]. Although all these facts and that all technologies and knowledge needed to ZEC is available, realizing ZEC is still at a very limited level [12].

RESEARCH AIM AND OBJECTIVES

The aim of this study is to elucidate the barriers impeding broad adoption of Zero Energy Construction.

RESEARCH METHODOLOGY

Emerald Group Publishing and Science Direct were used to find relevant articles to this topic. The following keywords are used: 'zero energy', 'net energy buildings', 'sustainable development', 'construction', 'barriers' and 'environmental management'. Barriers related to a broad adoption of sustainable constructions or ZEC have been analyzed and discussed.

RESULTS

The environmentally passive culture

The construction sector could be characterized by low levels of innovation [12] and environmentally passive culture [2]. Contractors are aware of environmental issues but they are not environmentally proactive [2], they do not initiate environmental protection measures.

Contractors build constructions in response to clients' requirements. Contractors often doubt about the client's willingness to pay for advanced energy efficiency and renewable energy systems [9]. Many clients have little or no knowledge about ZEC features which are invisible for them. Clients are not concerned potential benefits from improving environmental performance that may occur in the future; they are more concerned immediate or short term results [1]. Contractors will not invest resources voluntarily to implement environmental friendly measures if clients do not show interest in improving environmental performance. They would only implement it if clients ask for it [2].

To stimulate the market competition between sustainable and unsustainable constructions, government and local authorities have developed statutory regulations. Contractors should implement environmental friendly measures to meet the minimum requirements of these statutory regulations. However, these requirements are still on the very low level.

In developed countries, financial incentives have been developed to found the extra initial costs of environmental measures. The most of these incentive programs are and still cannot attract good interests from the industry [1]. However, implementing environmentally friendly measures can only be effective if it is implanted in the psyche of contractors [2].

Investment barriers Construction businesses are driven by short term profit-making [13] which construction cost is one of the most important factors affecting management decisions for this business. Certainly, implementing environmental friendly measures to achieve the energy neutrality will induce extra initial costs. Contractors would not implement environmental friendly measures because the benefits from the implementation will not outweigh the costs incurred [5, 1, 14]. However, environmental measures seem more readily to be sacrificed when cost an important criterion is considered.

Benefits from environmental measures could be only realized during the operational period of the construction [15]. The benefits of ZEC thus are mainly for the end users, not for the project clients or contractors. Extra costs of environmental measures thus are not considered a profitable investment [5, 14]. There is no agreement for financing the initial costs and enjoying the long term benefits of ZEC. In such a situation, contractors and clients will not invest in environment measures.

Contract forms and environmental performance Traditional construction procurement routes, such as lower bidder contracts, force contractors to focus on the lowest price bidding and not more on the value that can be added through implementing environmental measures. Contract time is also an aspect that can influence the performance of environmental measures. In traditional procurement routes, Contractors always work under pressure to a tight schedule. They will not be able to experience new technologies or environmental friendly measures due to time and price. However, better environment performance is achievable only if enough time and money are provided [2]. Traditional construction contracts will fail to meet the requirements of ZEC.

Cooperation and communication ZEC is not construction as usual; it needs a high level of knowledge and experience that is not available in most construction firms. On the one hand, involving several professionals and construction firms in the construction process will cause functional gaps where communications among the project team members is lacking. On the other hand, applying a multi-level subcontracting system in the construction delivery process will cause management discontinuities, where responsibilities for individual

performance are difficult to be monitored and measured [5, 16]. As result, operational islands will exist which coordination is ineffective and communication is very poor. Monitoring the common goal of the project will be difficult.

DISCUSSION

In fact, implementing environmental friendly measures to realize a ZEC needs the full cooperation from all project team members, and this should be communicated timely and effectively as the project team's common goal. This has to take place along with the client. If there is the lack of participation by clients in promoting ZEC, there will be no effective implementation of environmental measures along the whole construction chain from designers, consultants, contractors, subcontractors, and suppliers. Realizing ZEC will be impossible. Cooperation with other contractors and parties from different construction disciplines in the form of a project team throughout the whole construction process and life cycle of the construction is thus very necessary [13].

Contractual relations where costs and profits of long term energy savings are brought together will meet the requirements of ZEC. Thus, to organize the whole process of ZEC and to guarantee the final results, innovative contracting methods should be used, such as performance-based contracts. In addition, more attention should be paid for funding the extra costs and improving the performance in the operation phase.

CONCLUSION

Technically, ZEC is possible; projects have been realized that achieved energy neutrality. Because of the complexity of ZEC and the environmentally passive nature of the construction industry, there is no agreement for financing the initial costs, sharing responsibilities and enjoying the long term benefits of ZEC. The supply chain is too much fragmented, and monitoring of individual performance is lacking. To overcome these barriers and to optimize the initial funding-receiving benefit issue, innovative performance-based contracting forms are needed, which take into account the whole life-cycle. Performance-based contracts will enable the financing of high initial costs, fairly enjoy the benefits, insure high individual performances of project team members and guarantee the final results of the construction. Long term financial commitments of the whole chain of designers, builders and users of the product of construction will result in a more rapid development of ZEC construction products.

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