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Procedia Environmental Sciences 5 (2011) 173–177

**Procedia**

Environmental Sciences

2010 International workshop from the International Congress on Environmental Modeling and Software (iEMSs2010)

## Sustainable design for low carbon architecture

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### Abstract

Low carbon architecture designed according to sustainable principles is becoming an important part of the journey towards achieving sustainable development of economy, society, natural environment and architecture itself simultaneously. The definition, principles and factors considered in design have been investigated in details in this paper. A Three Rings Models of sustainability proposed by author is useful for understanding mechanism of sustainable design.

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*Keywords:* Low carbon architecture; Sustainability; Sustainable design; Principles of sustainable design; Factors considered in design

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### 1. Introduction

Climate change in characteristic of global warming which may bring serious natural disasters to humans was an indisputable fact upon us. The data studies show the scientific evidence of global warming across a spectrum of indicators. From this evidence it follows that there will be impacts, the severity of which will depend on the level and pace of CO<sub>2</sub> emissions. Following the situation of environment getting to increasingly severe, the whole world initiates to develop low carbon economy, to popularize new life style of low carbon, to reduce the carbon intensity by using the way of decreasing the carbon emission. The essence of low carbon economy is to make energy sources in efficient utilization, to develop clean energy, and to seek green GDP, which gives an influence on the development of architecture directly.

It has long been recognized that architecture in construction and in use contribute significantly to CO<sub>2</sub> emissions, which was estimated more than 50% of total emission. The architecture, including community, building and housing in general, and the activities of humans, such as energy and material consumption and waste minimization, and related them to the continuing support of natural resource, can be produced a large amount of harmful emission. So, we now need to design and construct sustainable low carbon architecture to meet environmental targets generated by international policy organizations, such as the Kyoto Protocol, and to create the user-friendly environment that promote well-being and personal enjoyment. Early definition of low carbon architecture emphasized balance between the need of living organisms, architecture and climate. During recent years, the development of passive low energy architecture has referred low carbon architecture in the context of sustainability. Hence, we may redefine the low carbon architecture as a sustainable architecture base on a human ecology with the sustainable development of economy, society and architecture simultaneously.

Because of the complex relationship and their interactions between the architecture and other three parts, i.e. economy, society

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and natural environment, sustainable design should be holism which relates to the way in which these parts and their associated performance attributes combine to create a whole .To understand the sustainable design process, we just simply use a three rings diagram to illustrate interdependence and connectivity of parts of sustainability (see Figure 1).

In Figure 1, sustainability contains four parts: low carbon economy, society, natural environment and architecture. Each part has subsequent factors shown as below.

- Natural environment: Orientation, Climate, Infrastructure , Light/ Space/ Ventilation, Energy/ Water.
- Low Carbon economy: Added Value, Flexibility, Commercial Reality, Longevity.
- Society: Culture, Social Benefits, People, Health and Well-being.
- Architecture: Form and Function, Identity, Structure, Materials, Innovation.

We conclude that architecture is not only an exercise judiciously balancing considerations internal to the building. The building itself enters into a complex whole where the successful resolution of the project depends on the achievement of a harmonious dynamic interplay between the architecture and the surroundings that as three rings shown in Figure 1.

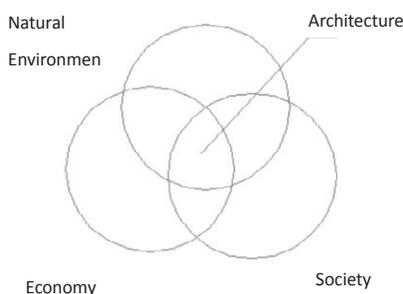


Figure 1 Three rings of sustainability

## 2. Sustainability in architecture

### 2.1 Sustainability

Sustainability means continuing, evolving, and adapting to renewable. Usually, sustainability is emerging as a key issue in economy and society. Now, the challenge of climate change leads us to introduce sustainability in architecture. As we know, architecture is about creating a better living space for human life and development, as well as considering the nature and resources of the planet from a global sustainable perspective. Sustainable architecture must not solely become a question of CO<sub>2</sub> emission reducing. It is necessary to consider sustainability from a holistic point of view that considers financial, cultural, and social issues as well as wider ecological and environmental aspirations.

As it is production of conventional energy sources that produces carbon dioxide, the first step will be to find ways in which to reduce the energy consumption of the buildings. This means minimizing the need for everything that requires power, e.g. air conditioning, mechanical ventilation, and artificial light, etc. The second step would be to use sources of renewable energy wherever possible in the planning of the future master plans.

### 2.2 Factors considered in sustainable design

For us, sustainability is a humanistic issue which has come to mean all things to all people. It is really a system that will continue to evolve for a sustainable architecture with its surroundings. So that, sustainable design based on holistic approach can bring a greater connectivity between people's well-being, environmental considerations, technological possibilities and nature itself which is fundamental to a sustainable future.

It is common to attempt to minimize the environmental impacts of buildings by selecting environmental criteria which are used to inform the design process. BREEAM, a UK Sustainable Building Code issued in 2006, describes the environmental

factors involved in compliance. We believe this is a better description for environmental considerations in sustainable design. Also, it is better to employ the economic and social factors in the sustainable design process. As a result, we suggest a list of factors that it should be considered in sustainable design, which is shown in Table 1.

Table 1 Summary of factors for sustainable design

Categories	Factors
Energy and CO <sub>2</sub> emission	Dwelling emission rate Building fabric ,Drying space Internal Light and External light Energy labeled white goods Low or zero carbon technologies Cycle storage Home office
Water	Indoor water use External water use
Materials	Environmental impact of materials Responsible sourcing of materials -basic building Elements and finishing elements
Surface Water Run-off	Management of surface water run-off from developments Flood risk
Waste	Storage of non-recyclable waste and recycle household waste Construction waste management Composting
Pollution	Global warming potential of insulants NO <sub>x</sub> emissions
Health and Well-being	Daylight Sound insulation Private space and lifetime homes
Management	Considerable constructors scheme Construction site impact Security
Land use and Ecology	Ecological value of site Ecological enhancement Protect of ecological features Change in ecological value of site Building footprint
Microclimate	Vegetation Wind mitigation/channeling Topography

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	Social diversity
Society	Cultural heritage
	Low impact mobility
	Law and regulations , Context

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Source: UK Code for Sustainable Homes, 2006, last two categories was supplemented

### 3. Principles for sustainable design

In a new low carbon age, the design professions adopt sustainable design to approach sustainability in architecture. Based on a theory described by three rings model of sustainability and holistic approach, we summarize basic principles for sustainable design as follows.

#### 3.1 Principles for giving top priority to the sake of the whole, based on conception of respecting the nature.

Sustainable development has commonly to be understood as economic and social development that maintains growth within the acceptable levels of global resource depletion and environmental pollution. This lets sustainable design can be viewed as a matter of coordination in economic, social and environmental factors within organizations. The view of sustainable development in architecture has led a number of approaches to designing buildings that assist in reducing pollution and resource consumption, in which holism is fundamental to the design of sustainable buildings.

#### 3.2 Principle of satisfying the needs of joint, sustainable and harmonious development between humans and nature.

Sustainable architecture must be from a view point of satisfying demands and development of humans. In any case, one can not destroy ecological environment in order to meet demands of humans, or one cannot neglect demands of humans in name of protecting ecological environment. Considerations must be given to both demands of humans and the development of ecological environment.

#### 3.3 Principle of making full use of natural resources according to rule of less consumption and more utilization.

It is important to place emphasis on energy efficiency, the full use and recyclable use of resources, which yields rules of 4R in design process.

- Rule of reducing: this rule requires reducing the needs for energy, water, land, and materials used in buildings. Perhaps it can be simplistic for the design focus to be centered on consumption for winter heating, summer air conditioning and light. For this purpose, many technologies have been developed, such as improving natural ventilation of microclimate and active systems, using clean and renewable energy systems, and selecting sustainable materials and water, which can be taken account into the design. Sustainable materials are less energy intensive in their production and that are not harmful to the environment.
- Rule of recycle: Sustainable design should select the recyclable materials as the building materials where possible. At present, the rain water recycling and wastewater systems may be the examples for this.
- Rule of reuse: The continuous usefulness of most building materials must be considered in design process, which means that at the end of material useful life it should be used as postconsumer resource and give new life in the form of new materials and fabricated components of recycled into new materials and fabricated components or alternative uses. The approach to the construction of any new facility should be to maximize the efficiency of the building fabric in order to conserve resources in future operation. In this context, the existing building stock must be seen as an important resource.
- Rule of renewable: It should be to make widest possible use of renewable sources in sustainable design. Renewable energy is source from renewable sources, which are not rapidly replaceable. Many renewable energy have been developed, such as wind energy, photovoltaic systems, solar thermal systems for water heating, ground source heat pump for heating and cooling. etc., which are adopted in recent projects more and more.

#### 3.4 Principle of using suitable measures to local conditions to creating user-friendly environment.

This is a principle for a place-based design, which means design of planning based on the incorporation of sustainable principles, powered by local energies, built with local materials and local labor, and respectful of region and culture. It is recommended to adopt passive design strategies. The fundamentals of passive design are commonly seen as the creative use of building planning to link buildings with their environments and their microclimate.

### 3.5 Principle of creating flexibility for buildings by adjusting links in designing process.

Considerations on development of buildings must be taken into account in sustainable design. Based on analysis of core function and possibilities for flexibility over time of buildings and its surroundings, it is important to seek to humanize the built environment by designing buildings in tune with their context and resonating sense of place.

## 4. Conclusions

Low carbon architecture which is responsive to developing of low carbon economy has been defined as a sustainable architecture with sustainable development of economy, society, environment and architecture itself simultaneously. Sustainability in architecture comes from sustainable design which is a dynamic and living process. A three rings model of sustainability proposed by author is useful for understanding the mechanism of sustainable design process, rather than a more complicated model. Principles and factors to be considered in sustainable design have been investigated in this paper. Sustainable design had much difference from traditional design may be carried forward intensive design, efficient design, smart design, suitable design and interdisciplinary cooperation.

China now pays great attention to low carbon buildings. A National standard for Green Building Evaluation GB/T50328-2006 was issued in 2006, and many green buildings were built, in which a famous one is the Expo's China Pavilion Building in Shanghai, China, 2010.

## Acknowledgements

A special thanks to Mr. Zhou Shiyi, President of Beijing Development Area Co., Ltd, who has given me much encouragement and valuable discussions to publish this paper.

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