GENERATING A GREEN TEMPLATE FOR ACHIEVING A ZERO CARBON BUILDING AND SUSTAINABLE ARCHITECTURE

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ABSTRACT

The United Kingdom first announced its Zero carbon home policy in 2006 by the then chancellor Gordon Brown who said Britain was the first country to make such an announcement. New buildings must meet strict minimum energy efficiency parameters as part of the definition of 'zero carbon', both in terms of the building design and appliances. However, the fact that the UK had backtracked on its earlier commitments, does not diminish the significance of such a laudable scheme in ensuring that emissions from buildings are minimized and our planet safe. It is a commonly reported fact that around half of all global CO2 emissions can be attributed to construction, and more importantly the operation of buildings encapsulated as embodied energy, transport and operational energy with fossils as primary source of energy. The architectural profession must navigate towards a framework for sustainable design and construction that is in consonance with the global norms and concepts of sustainable development and construction technology; reforming design processes and design education in a new and sustainable way.

A significant emphasis must be geared towards the need for a paradigm shit of design transforming nature to one that transforms society towards sustainability by improving the life quality, symbiotic relationships and relationships between all living things, communities, natural and the built environment. There will also be the need of exploiting the potentials of ecological design and other green and renewable options in the built environment. Again, the role of architects as engine and agents of change cannot be overemphasized as their design and

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decision can constrain, alter, guide or enhance future decision or completely mar their outcome. This research will specifically advocate the promotion of new technologies, systems of production and construction methods that do not rely on natural capital, harmful chemical and fossil fuel thus promoting incorporation of renewable technologies and modern techniques and formatting a new partway and templates to a zero carbon Architecture.

Keyword: Sustainability, Zero Carbon Building, Green Architecture.

INTRODUCTION

The Earth,
"*Viewed from deep space, our entire habitat of land, oceans and clouds is revealed as a thin, delicate glaze – its beauty and vulnerability contrasting with the stark and sterile Moonscape, on which the astronauts left their footprints*;"[1] is just the most perfect place in which to live: its continents and islands, oceans, lakes and rivers support an amazing abundance and variety of life. Our planet provides the ideal incubator and shelter for this to happen. Water, as a regulator of temperature and transporter of nutrients, is essential to life. Water is available on Earth as solid ice, liquid and vapour forms. The global interchange of glacier ocean-atmosphere systems maintains a comfortable environment to support life forms from polar bears to tropical parrots. Earth is just close enough to its shepherding star, the sun, to receive warmth and light but not to burn up living organisms.

However, human intervention and activities is set to upstage and transform this magical harmonious planet we call home into cauldron of fire. A critical introspection indicates that each kg of Portland clinker emits almost 1 kg of CO2 to the atmosphere during production[2]. This informs why it makes good sense for Architects and the Building construction experts to design buildings with minimum energy consumption in mind to keep down the carbon footprints of such projects at local and global scale.

DEFINITION OF ZERO CARBON BUILDING

A zero carbon building is a building with zero net energy consumption or zero net carbon emissions on an annual basis. Another definition of zero energy building (ZEB) is provided by Trocellini et al [3] as: "a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies". In many countries, zero carbon or low carbon buildings have been the focus as an important strategy at energy conservation and reduction of greenhouse gases emissions [4]. There must be convincing reasons why long-established practices should be replaced for change to be widely accepted.

Environmental degradation is foisted by the practices of perpetual use of fossil fuels, creating a hostile climate through excessive greenhouse emissions. The US Department of Energy (DOE) has set up a strategic goal to achieve 'marketable Zero-Energy Homes in 2020' [5]. However, the jettisoning of its Zero carbon home policy of 2006 just recently by the UK is as stunning as Brexit with attendant and foreseeable consequences. In this case, its decision to vacate this policy will haunt the UK and for a long time.

Sustainability emphasises the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs [6]. Sustainable development envisions a symbiotic balance between two pursuits that are often portrayed as mutually exclusive; maintenance of a sound environment, economic and social development [7, 8].
Buildings are particularly implicated in this process, being presently responsible for about 47 per cent of carbon dioxide emissions across the 25 nations of the European Union. This being the case, it is appropriate that the design and construction of buildings be a prime factor in the drive to mitigate the effects of carbon dioxide emissions and its domino effect on the climate. This reinforces the need for indebt research in the next generation of low carbon buildings.

BUILDING DESIGN AND ENERGY CONSIDERATIONS

The current model in buildings energy efficiency combines a rafter of design considerations such as envelope efficiency, passive and active solar features, efficiency in equipment, appliances and lighting including photovoltaic and other renewable sources to achieve zero energy targets. In buildings usually, increases of heat insulation and top performance windows are among the most important energy-conserving methods (Hestnes et al.[10], 1997, Hensen and Nakahara, 2001)[11].

During the past 30 years, a great number of experimental buildings have been erected to measure energy conservation achieved and to serve as lessons for future design. These experiments demonstrated that buildings having very low energy consumption can certainly be designed and constructed but that this requires adequate knowledge, attention and control. (Hestnes et al., 1997)[12]. Architects, Engineers and other building construction experts must continue to engage in alternative sourcing of environmentally friendly materials and options with acceptable carbon footprints to forge ahead. This must also cover system and appliances efficiency and open ended research for new and compliant construction material that are sustainable with green credentials. Lifecycle energy use in buildings can be monitored and measured as a low carbon development strategy as well as being seen from the perspectives of energy use, emissions and economic growth in terms of GDP per capita of countries in real-time (Figure1to Figure 4). The question of carbon trading is viewed as indicator of good business when assessing the alternative and renewable energy global market where countries can trade-off excess carbon footprint to other countries that emit less greenhouse gases thus stimulating economic activities on a global scale as incentive for the green agenda.

Ecological architectural design synonymous with Zero carbon architecture encompasses appropriate design of architectural forms, air-tightness, optimum ventilation, selection of building materials from the category of least scarce resources ('green building materials'), energy conservation, HVAC control, good

heat insulation and shading, thermal storage, replacing ozone layer depleting heat insulation and cooling equipment. Others are protection of air, soil and water purity, recycling of wastes, increased attention to maintenance and renewal of buildings (Stratton, 2000).

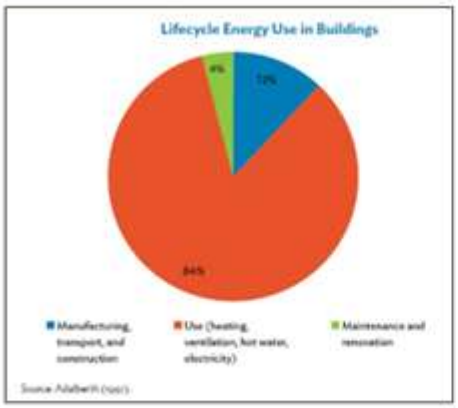

Figure 1 : Societal and Lifestyle Choices as a low-carbon Strategy

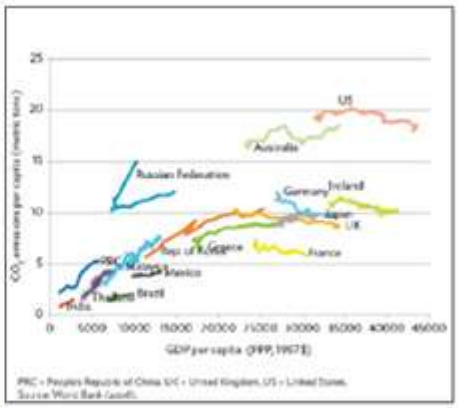

Figure 2: Energy Use, Emissions, and Economic Growth of Countries

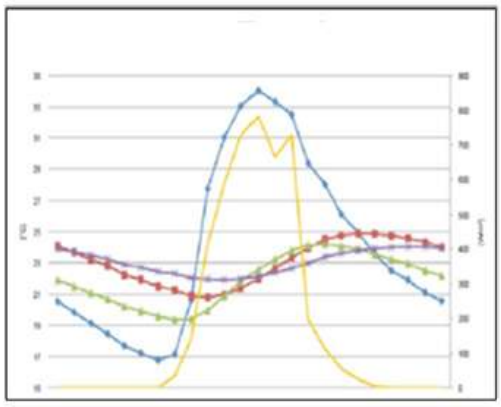

Figure 3: Tracking Surface Temperatures

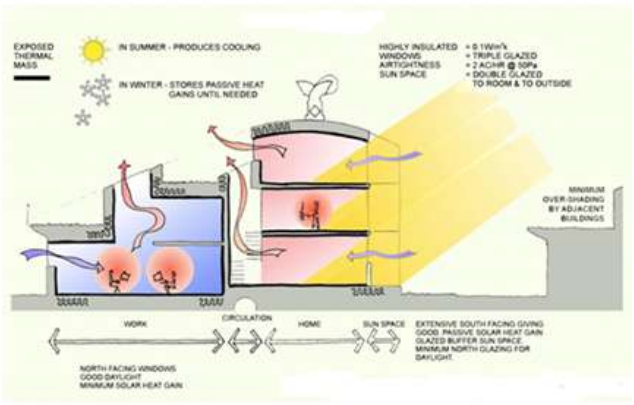

Figure 4 : Building Physics

RESEARCH OBJECTIVE

Protracted and often heated debates on possible routes out of Climate risks and achieving Zero Carbon Architecture especially in the domestic sector had dominated discuss on the subject, suggesting roadmaps and routes to decarburizing the built environment and even the power sector.

The aim and objective to zero carbon building is one designed and equipped to offset operating energy consumed from the grid by on-site renewable energy generation. Then such a facility can then be said to be carbon neutral if the operating energy from the grid is neutralised by the on-site renewable generation and also negate the carbon footprint of its construction over time. This research will sort to create such a deserved Architecture that not only strives to achieve this goal but to make a sustainable pathway to future green buildings.

MOTIVATION

According to a book authored by Spiegel and Meadows (1999) [11]; Green building materials are those that use the Earth's resources in an environmentally responsible way. Green building materials respect the limitations of non-renewable resources such as coal and metal ores. They work within the pattern of nature's cycles and the interrelationships of ecosystems. Green building materials are non-toxic. They are made from recycled materials and are themselves recyclable. They are energy efficient and water efficient. They are 'green' in the way they are manufactured, the way they are used, and the way they are reclaimed after use. Green building materials are those that earn high marks for resource management with impact on indoor environmental quality (IEQ) and performance (energy efficiency, water deficiency, etc.). The future of infrastructural developments with building provision in sharp focus must embrace the renewable and sustainable path to guarantee our continued existence on this beautiful planet.

JUSTIFICATION

Since the service life of most buildings are often 50-70 years or even more, the annual energy consumption has very large impact on the total carbon footprint of a building. For this reason alone, it makes good sense to design the building with minimum energy consumption in mind. However, due to the complexity of actually completing a building and the huge carbon footprint that trails the process, the entire business of project delivery must be viewed through the prism of; energy efficiency, building's energy performance, the thermal coefficients of materials and the green credentials of appliances. To create a zero carbon building as a

sustainable path of the future is to set the tone for an environmentally friendly built environment.

METHODOLGY

The identification of the fact that Zero Carbon Architecture is one of the sure routes to extricate the environment from the imbroglio of worsening global climate into a more environmentally friendly landscape is not an over statement. This research adopts an extensive literature studies, case studies and interactions with experts and stakeholders in this field. The use of a range of information gathering tools are employed and also the internet route, examining works and resources in this field will remain a valuable strategy, not ruling out tangible experiments and laboratory simulations. There is no belittling the fact that this area of study is still developing globally as individuals, organisations and experts scamper to advance the necessary technologies and sharpen the skills and knowledge necessary to achieving building efficiency that helps create a zero carbon environment with a global acceptance. The significance of this study demands wide spectrum interactions to gouge varied opinions and postulations from all sources as there are sceptics who deny that global warming is occurring. However, the scientific community are in no doubt that largely human intervention is the result of global warming and the evidence abounds from extensive scientific probing of the environment. Buildings are the largest energy consumer by sector and account for over one third of global final energy consumption [3], thus making it a key sector of interest regarding curbing carbon emissions and slowing down the current pace of global warming.

DISCUSSION

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The first zero carbon building in Hong Kong which is designed and equipped to offset operating energy consumed from the grid by on-site renewable energy generation is situated at Sheung Yuet Road, Kowloon Bay, Kowloon in Hong Kong [14]. This facility can then be said to be carbon neutral if the operating energy from the grid is neutralised by the on-site renewable generation and also negate the carbon footprint of its construction over time. Even a limited amount of offset will be of significance knowing the precarious disposition of the climate and its predictable effect on entire humanity, our corals. Our planet is at risk as we know it with extinction dangling on a knife-edge. This had been achieved with a cocktail of renewable energy systems and greening of the surrounding environment creating a micro-climate that offsets the carbon footprint; embodied energy, transport energy and construction carbon footprint.

Figure 5: Nature's delineation of Zero-carbon template

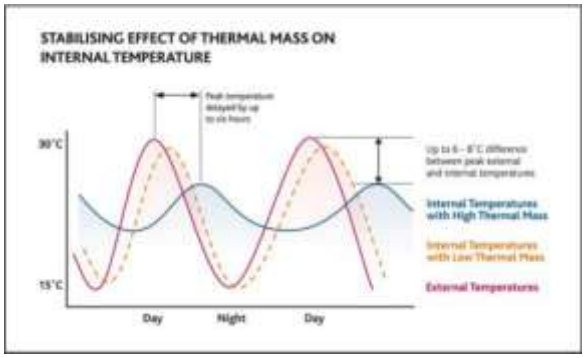

Figure 6: Human Zero-carbon solution

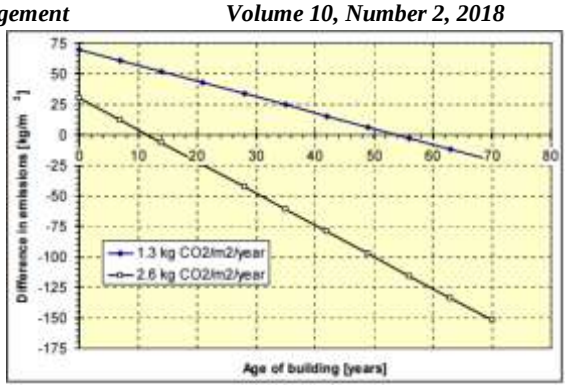

Figure7: Effect of high thermal mass on daily temperature

CONCLUSION

There is a school of thought that argues that the creation of the built environment is, in itself, an unsustainable act as it collects materials from one place and assembles them in another in a manner that does not easily or readily allow them to be so collected again. Purporting to design for sustainability therefore would appear to be a direct contradiction, if not a blatant deception. However this research punches holes in such aphorism on the premise that an ecological and sustainable approach will be rewarding by integrating natural and renewable path without major disruption to the natural habitat or environment. As climate risk is at the centre of a situation that will know no geographical barriers and in most cases worse in some destination, the accomplishment of Zero Carbon Architecture cannot be overemphasized. This because the construction and building sector including when the finished product is in use is high-up in the emission A-list and every effort at mitigation must be channelled to achieve a sustainable carbon free future and eco friendly environment.[15]

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