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NEED FOR ENERGY EFFICIENT BUILDINGS IN NIGERIA

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ABSTRACT: *This paper x-rays the ingredients and integration of solar passive designs with solar architecture for increased energy efficiency in buildings to achieve maximum comfort, reduced green house gases, reduced energy cost and ensures available clean and sustainable energy in such homes. Energy efficiency in buildings is one of the fundamental steps towards reducing the agents/factors that could lead to global warming and climate change. It is a common knowledge that global warming is becoming more severe universally and poses very big risk to man. In Nigeria, most buildings hardly take solar architecture and energy efficiency into consideration due to ignorance, poverty, lack of awareness and/or improper policy on building regulations by Government. Use of mechanical devices to achieve thermal comfort in buildings is not only capital intensive but also generate greenhouse gases, air and noise pollution amongst others. This paper identifies the factors hampering on the use of energy efficient buildings and solar architecture in most buildings in Nigeria. It also proffers possible solutions and the way forward.*

KEYWORDS: Solar architecture, energy efficiency, solar passive building, building integrated photovoltaics, climate change.

INTRODUCTION

Solar passive building is a technology aimed at using natural concepts to achieve comfort in buildings without use of artificial devices. Solar architecture combines solar panels with modern building techniques to achieve an eco-friendly building. Energy efficient building mostly incorporates solar architecture with modern technologies such as BIPV (building integrated photovoltaics), use of solar fridges, solar water heating, and energy efficient building materials to ensure that maximum comfort is attained with reduced energy cost without harm to the environment/climate. Currently, most buildings in Nigeria lay more emphasis on the aesthetic values with little or no consideration for energy efficiency. Recent studies by Malgwi and Musa (2014), and Oyedepo (2012), reveals that building materials should be carefully selected to enhance thermal comfort in buildings in hot-dry climatic conditions. Nigeria is located in the tropical region with latitude 10.0N and longitude 8.00E (Menakaya and Floyd, 1980) with a mean total solar radiation of 500W/m^2 (DanShehu and Sambo, 2006). The Nigeria housing sector is

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more saddled with provision of enough homes for the teeming populace without much consideration on the impact of non-energy efficient homes on the environment, economy, health and on the society in general. It has been established that cities contribute large quota of green house gases (GHG) which unarguably are one of the major agents of global warming. The change in micro-climate due to a rise in temperature in the urban areas compared to their surrounding as a result of human activities otherwise known as the "urban heat island effect" (Luke, 2010., Glossary of Meterology, 2009) is also very common in Nigeria due to unchecked urbanisation in some States. However, the urban heat island effect can also depend on other parameters such as nature of urbanisation, urban size and form amongst other factors. These effects can be minimised through the use of energy efficient buildings. Integration of solar architecture with energy efficient building materials and devices (solar fridges, energy saving bulbs e.t.c) into the architectural design of buildings will lead to eco-friendly cities in Nigeria. This paper will attempt to provide an insight into:

(i) energy efficient buildings and factors militating on its proliferation in Nigeria,
(ii) impact of non-energy efficient buildings in relation to human comfort, economy, environment, global warming and climate change,
(iii) suggest possible solutions and the way forward.

ENERGY USE IN NIGERIA

Nigeria has a broad base and abundance of fuel sources: hydro, natural gas, coal, solar, wind and geothermal. However the use of these fuel sources has been largely skewed in favour of hydro power and crude oil, leaving the other sources either untouched or poorly harnessed. It has been established that fossil fuels accounts for 94% of exports from Nigeria in 2006 with only a small fraction of this available for domestic use and about 40% of households connected to the national electricity grid (Akpu, 2012). Thus, the GHGs associated to fossil fuel consumption in such areas will be likely higher thereby increasing the risk of global warming and climate change. Greenhouse gases are also produced from other sources either natural (combustion, respiration) or artificial (deforestation and other human activities). A large percentage of Nigeria's populace relies on fuelwood for cooking (Nwofe, 2013) which then makes the environment largely polluted with green house gases such as carbon (iv) oxide and carbon (ii) oxide. The housing sector accounts for a reasonable quota of materials and energy that lead to green house gases. The United Nations Environmental programme (UNEP) sustainable construction and Building Initiative (SCBI) noted that 30-40% of the global energy use comes from the housing sector (U.S. Environmental Protection Agency, 2012). This implies that use of energy efficient buildings will offset the green house gases (CO_2, CO, CH_4) by 30-40% which could have emanated from the housing sector thereby saving our climate from the negative effect of these gases.

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ENERGY EFFICIENT BUILDINGS

Energy efficient buildings are designed in a way that ensures that energy is used at a reduced cost, and in a sustainable and conserved manner. Energy efficient building is a panacea to attaining a "sustainable city or eco-city". Eco-cities are designed to achieve maximum comfort by occupants with emphasis on reduced energy inputs, water and food, waste output of heat, and reduced air, noise and water pollution (Devuyst, 2011., Eco-city, 2011.,). Energy efficient building is relatively unknown in Nigeria due to certain factors which include: ignorance/illiteracy, poverty, lack of awareness and/or poor Government policies toward achieving such concepts in buildings.

Ignorance/illiteracy

Most developing countries are known for high illiteracy rate. According to the report of the Minister of State for Education in Nigeria, adult illiterates rose from 25 million in 1997 to 35 million in 2013 (Vanguard, 2013). Specifically adult literacy rate is about 56.9% of the total population (National Bureau of Statistics, 2010., Murtala et. al., 2013). This makes the focus of most citizens on buildings to be more on quick gains without consideration on sustainability of the environment and climate. Also with such high degree of illiteracy, majority of the citizens need to be educated on the need for energy efficiency in buildings to enable them understand the merits.

Poverty

Nigeria has a population of 2,176,947 based on 2006 census (National Population Commission, 2006, National Bureau of Statistics, 2010). The poverty rate in Nigeria is still alarming. In Nigeria, an estimated 54 per cent of the population lives below the poverty line (43 per cent urban, 64 per cent rural), and 90 per cent of the poorest people live in the north (Nigeria Country Programme document, 2014-2017, Unicef). Poverty is a strong limiting factor to energy efficient buildings as money is needed to procure the materials and human resource needed to execute such buildings.

Lack of awareness

Most Nigerians are not aware that buildings can influence our environment and climate. They are more concerned with the aesthetic values and volume of modern technological gadgets in buildings without knowledge of the negative implications of such devices. In some rural areas, seasonal variations and weather changes which are possibly due to climate change are rather attributed to primitive religious beliefs. Thus the need for awareness on the influence of energy efficient buildings on the environment to be created in the minds of the citizenry cannot overstressed.

Lack of Government policies

Lack of Government policies on achieving energy efficient buildings for sustainable environment and development is another contributing factor. The Government (Federal. State and Local) are yet to come up with strong policy that will ensure that buildings are regulated to ensure that energy

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efficiency is achieved. Currently, the Nigerian government has set a target to increase electricity generation by 40,000MW of power by
the year 2020 (Nnaji, 2012) and subsequently, many gas-powered stations have been commissioned to increase generation and many more are expected to be commissioned to meet up with energy demand. These are non-renewable energy source and will result in the emission of GHGs, leading to global warming to consequently increase climate change. Increased urbanisation in most States especially in the housing sector will also add its quota of GHGs to the atmosphere.

FACTORS THAT PROMOTES ENERGY EFFICIENCY IN BUILDINGS

These factors includes solar architecture, solar passive systems, active systems (BIPV, energy saving bulbs, solar fridges, solar water pumping, solar fan, solar watches, etc), and attitude of occupants in such buildings. Energy efficient buildings are mostly achieved through bioclimatic architecture, high performance building envelope, and controlled ventilation.

Solar architecture/solar passive systems

Solar architecture is the act of integrating modern building techniques with building integrated photovoltaics to achieve thermal comfort with reduced building and energy cost. Materials needed for solar architecture are those ingredients that will lead to either thermal cooling or reduction of peak cooling power demands of a building (Chwieduk, 2004). Nigeria is a tropical country with two major seasons (dry and rainy season). Nigeria is roughly divided into higher temperature region (Northern states) and lower temperature region (East, South and Western states). Solar passive systems is designed to make a building itself to either gain as much solar energy as possible or to loose heat depending on the season and prevailing climatic condition. Solar passive architecture enables buildings to utilise the energy of the sun for its needs without employing active devices such as BIPV, solar fans or solar water heater. To achieve this, such buildings usually incorporate materials with high thermal mass that will retain heat effectively and good insulation to prevent heat loss. Also a low surface area to volume ratio is ensured to minimise heat loss in such buildings. The indoor thermal comfort can also be improved through "passive cooling". The techniques for passive cooling can be preventive, modulation, and heat dissipation techniques (Santamouris, 1996., Givoni, 1994). Direct cooling include ventilation, infiltration, courtyard, wind tower, air vents and earth shelter while indirect cooling is through evaporative cooling, shading, etc (Tiwari, 2006). Sun charts are also used to determine shading devices of the building pattern such as wing walls and overhangs in which angular sun charts and overhangs are entered on the same plot (Crosbie, 1998). The U.S. Environmental Protection Agency, EPA (2012), noted the passive features that enhance energy efficiency in buildings to include; roofing, ventilation, natural lighting, window materials, building shape and orientation, colour of the wall, and trees and shrubs. Proper passive design can improve the energy balance of the interior of buildings as

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well as its exterior and aesthetic impression of an observer (Balcomb, 1992). Bioclimatic architecture combines the use of climatic and environmental conditions to achieve visual and thermal comfort in buildings. This is achieved through; proper shape and orientation of the building, passive solar systems, and solar protections. High-performing building envelope is achieved through; proper insulation, elimination of thermal bridges, thorough air-tight construction, and use of high performance glazing and windows. Controlled ventilation can be achieved through proper mechanical insulation and heat recovery.

Active systems

Active systems refer to those energy efficient man-made appliances which are either consumed by occupants or integrated into the building envelope. Energy efficient products do more work with less energy. Some of these products include BIPV, energy saving bulbs, solar fridges, solar water pumping, solar fan, and solar watches. Building integrated photovoltaics is the integration of solar cell panels on roof tops, skylights or facades. BIPV is one of the fastest growing industry in solar photovoltaics because the amount of money that could have been spent on building materials and labour in constructing part of the building which the BIPV module will replace is enough to offset the initial cost. Also PV systems have energy payback time of less than 1 year (for thin film solar cells) and typically 3-4 years for silicon based solar cells (Nwofe, 2013). Energy saving bulbs, solar fan and solar fridges has been proved to be more energy efficient than the conventional types.

Attitude of occupants in buildings

In Nigeria, there is wide ignorance on use of/switching off bulbs. The awareness on energy saving bulbs is limited to people in the urban areas while most rural areas are still using conventional bulbs. Also the price of the energy saving bulbs is still high. Research (The Cambridge-MIT Project, 2005) has shown that turning lights off when not in use would save a gigantic sum of £55m and 375000 tons of carbon (iv) oxide thereby preserving the environment and reducing energy cost simultaneously.

IMPACT OF NON-ENERGY EFFICIENT BUILDINGS

Human comfort and economy

Buildings that are not energy efficient require more mechanical/electrical devices to achieve thermal cooling in tropical areas and thermal heating for cold regions. These devices require enormous energy input and also generate green house gases. Also the cost of these devices are very exorbitant and not many people can afford it. The comfort of people in such buildings is in jeopardy. Due to the epileptic nature of power supply by the Power Holding Company of Nigeria (PHCN), most people rely on gasoline generators for power. This causes irritating noise and also increases the volume of GHGs within the vicinity. This not only lead to increase in global warming but also affect the economy through increased air-pollution related diseases. This has been highlighted in the literature (Abayomi, S. O., 2012, Bukola, O. B., 2012, Olawale, O.E., et al., 2012).

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Environment, Global warming and Climate change

Human activities affect the environment in many ways. Global warming due to GHGs is an inevitable concept because of some natural phenomena such as; photosynthesis, respiration, pollution, deforestation, and production of animals for food. The impact of global warming has manifested in; sea level rise and coastal flooding, longer and more damaging wildlife seasons, more frequent and intense heat wave, costly and growing health impacts, increase in extreme weather events, heavier precipitation and flooding, more severe draughts, changing seasons, melting ice, disruptions to food supplies, destruction of coral reefs, plants and animal range shifts, and the potential for abrupt climate change (Wikipedia, 2014). In Nigeria, flooding was witnessed at a very large scale last year, leading to serious food shortage especially to cassava farmers. Energy efficient buildings will play a significant role in reducing these GHGs and by extension, these negative impacts. Other authors (Abimaje and Akingbohungbe, 2013., Adeaga and Olaoye, 2013) has discussed relative scenarios.

CONCLUSIONS AND THE WAY FORWARD

Energy efficient buildings aims to reduce the demand for energy in buildings by; avoiding wastes and employing energy-saving measures in the building architecture, use sustainable energy source and energy-saving devices, and to reduce GHG emission to the barest minimum. For energy efficient buildings to be ensured in Nigeria, the author strongly suggest that:

(i) Government at all levels (Federal, State and Local) should do more to reduce the high rate of illiteracy in Nigeria. It is only when illiteracy is reduced that people will understand the need for "environmental sustainability" and work toward reducing the factors that could lead to it.

(ii) Government at all levels (Federal, State and Local) should try and reduce the poverty rate in Nigeria by opening up more job opportunities, ensure steady power supply, and diversify power sources by utilising the renewable energy sources that are abundant in the country.

(iii) Government should create awareness on the advantages of using energy efficient buildings over conventional buildings. This could be done through media, newspaper, schools, mobile communications, e.t.c.

(iv) Government should introduce strong policy on compulsory energy efficient buildings and ensure that every State adhere to such regulations. Indiscriminate waste of energy by leaving light bulbs on indefinitely in streetlights and in most homes and public buildings in Nigeria should be addressed.

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