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Nigerian Architects and Green World Development

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Abstract: Green world development, is an initiative to make the world sustainable, one that allows resources to be used without extinction, or one living well and the generations after him living as well as he lived. Buildings are known agents of environmental degradation, theycontribute to global warming. The architect is looked unto for solution. Nigerian architects are part of worldfamily expected to proffer solutions for green world, unfortunately they are limited because of paucity of information as Nigeria hasno operational energy regulations. The paper targeted, Nigerian architects, as it used literature to inform architects about green world, sustainability, energy, energy efficiency, (operational and embodied), forms of energy efficiency buildings. Itrecommended that Nigerian architects pay attention to research in order to compare with the world , and that Nigerian architects relate to their clients and offer expertise advice on site selection, orientation and project proposals. The need for critical thinking was underscored. The paper concluded that if Nigerian architects designfor cradle to cradle and not to grave, employing passive design, that green world will be realized.

Key words: Energy Efficiency · Green World · Sustainability and Sustainable Architecture

INTRODUCTION

Buildings are architectural products and every building has a unique design, character performance and responds to its composition and design [1]. “Architecture is a very dangerous job because if a writer makes a bad book, people don’t read it, but if the architect makes a bad architecture, he imposes ugliness in a place for 100 years”. Piano Renzo. Piano Renzo, in no small means stretches Frank Lloyd Wright’s assertion that the “architect lives with his mistakes.”

Buildings have significant impact on the environment, human health and accounting for one-sixth of the world’s freshwater withdrawals, one-quarter of its wood harvest and two-fifths of its material and energy flow (70%of electricity), with very large negative impact on the environment and health. Structures also impact areas beyond their immediate locations, affecting watersheds, air quality and transportation patterns of communities-over four-fifths of all transportation is from one building to another. Moreover, people in developed nations spend nearly 90 percent of their lives indoors, making the quality of the indoor environment key to good health [2]. The resources required to create, operate and replenish the level of infrastructure are enormous and are diminishing. By all accounts, we will have to replace three-quarter of the existing building stock and double the built environment in the next 40 years, to accommodate the demand. This is not possible without a radical change in the design, construction, operation and location of buildings [3].

The world is said to be facing strong environmental issues in ozone layer depletion, global warming, climate change, eco-system destruction, waste accumulation, acidification and resource depletion [4]. Buildings are known major contributors to the degradation, decay and environmental break down [5].

To realize a sustainable developments, a consensus to reduce to the lowest possible level 80% of global carbon emission by 2050 was reached [6]. This in no small degree underscores the architect as great force necessary in the race to purge the world of unhealthy environmental situations, when they infuse sustainable designs concepts that will cut energy consumption [7].

It is obvious that the climate is threatened by human activities and in consumption of natural resources without replenishment [8]. [9], acknowledged this to result from high energy demand in buildings. Residential, commercial, industrial, health, educational, religious buildings, etc. are the greatest consumers of energy and accounts for about 40% of world’s energy consumption. [10].

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In most developing nations in the world, especially in Nigeria, energy consumption has been on the increase due to population and economic growth. This increasing aspects of the people, has resulted in the creation of more buildings. High energy demand results into notable environmental problems such as global warming, which brings about increase in indoor temperature, air pollution and acid rain [11].

Buildings as known consumers of energy therefore contribute to climate change. This is because most energy used in buildings are generated from burning fossil. Fossil generate carbon dioxide and other Green House Gases (GHG), which endanger our climate and causes climate change [12]. Climate change affects buildings by increasing the indoor temperature, turning them into cells of unhappiness, poor air quality, growth of airborne diseases, suffocation and heat stress [13]. This is in contrast to the expectation of home makers [14].

The Green World Concept: Green world denotes sustainable way of living, where nature is being considered important besides consumption and production, where people use recyclable materials and material energy.The field of green world is vast and diverse, full of numerous jobs and specializations; all working together towards the same ideal: to create buildings that are sustainable; and ultimately regenerative [15].

Green building, also known as sustainable or high performance building. [16], is not a new concept because for thousands of years, passive solar design (daylighting) and the use of local and regional materials have been employed by man from creation to derive comfort in his dwellings. Green building involves architecture, engineering, interior design, construction, facility management, or real-estate professions that can incorporate sustainability into their approach. The aim of this paper is to unveil facts in literature necessary to inform and guide Nigerian architects towards the realization of green world., hence the review on energy, energy efficiency in buildings, sustainability, sustainable architecture, zero emissions, high performance designs, net zero buildings or by whatever other names authors may define them are architectural concepts believed to facilitate the crystallization of a green world.

Green building also refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation and demolition. This requires close cooperation of the contractor, the architects, the engineers and the client at all project stages. The Green Building practice expands and complements the classical building design concerns of economy, utility, durability and comfort and has also be called green construction or green building [17, 18].

Sustainability: Buildings consume one-third of the total energy produced in the world, produce 40 percent of the carbon dioxide emissions that have linked to global warming and air pollution and generate 33 percent of landfill construction waste. These statistics have resulted in a growing trend whereby are designed, constructed, operated, reused and deconstructed in ways that will enhance human health and protect environmental quality [19].

Sustainability is defined as maintaining, or keeping at a certain rate or level, avoidance of the depletion of natural resources in order to maintain an ecological balance. The meeting of the needs of the present without compromising the ability of future generation to meet their own needs [20].

Sustainable Architecture: Sustainable architecture is the expression coined for environmentally responsive building practices. It differs from conventional design by considering the environmental impacts of design decisions throughout the entire life cycle from cradle to cradle instead of cradle to grave. [21]. It provides a comprehensive examination of all aspects of architectural design including site selection, energy conservation, passive solar strategies and low-energy systems, building materials, indoor air quality, water conservation, waste minimization, lighting and use of renewable energies [22]. [23], appear to amplify McDonald (2004)'s definition by applying that sustainability to be we living well and our children, their children and children-children and their children living as well as we have lived without compromising the ability to meet their future needs. [24] is believed to be the root of Alozie (2019)'s definition.

The roots of sustainable architecture can be traced to the ancient theoretician Vitruvius who in The Ten Books of Architecture discussed the benefits of designing with the local climate and indigenous materials [25]. The skills of preindustrial builders, the mastery of using on-site resources such as proper orientation, thermal mass, shading, ventilation and local construction materials, were all abandoned after the invention of artificial lighting and air conditioning. Except for several notable exceptions like the organic architecture movement [26].

Buildings and sites that utilize natural systems to minimize their global, regional and local environmental impacts on land, energy, water and materials form the basis of “sustainable” or “green” architecture. Human health, economic affordability and social equity are also considered attributes of sustainable design [27].

Sustainability therefore should begin with energy utilization. The key to energy management is to reduce energy consumption, especially in buildings. To understand better energy usage in buildings; generation, consumption and preservation, the architect must align himself to preliminary knowledge of this, hence the following review.

Energy Studies Energy Crisis: Energy crisis is not new in the history of man. The early man, was the first to experience this when faced with predators that inhibited him from collecting and storing fire for warmth. Modern history however recorded early Greek and Roman civilization energy crisis and that of American Arizonans too and their management practices for survival. Energy crisis therefore occurs when inhabitants of earth or particular region or regions run short of materials that generate energy, fossil fuel such as wood, oil and gas. It is therefore important for man to develop energy efficient and zero emission buildings in our contemporary world if he has to avoid energy crises and the associated environmental hazards that may result from continued use of fossil fuel. [28], [29].

Energy and Energy Sources: Energy in is defined in [4], as the ability to do work. The very good thing is that energy is never created no destroyed, but transformed from one state to another. The concept of energy is somewhat abstract, we neither see nor feel it and yet we pay for it. Energy is like spirit of life, you neither see nor touch it but you know it’s there; electricity is among the commonest forms of energy available to man, it changes darkness into light, it powers phones and computers, operates vehicles, heats water and food, irons clothes, conditions homes and we pay for it. Yet we neither feel nor see it.

To have our indoor environment just right it becomes pertinent that architecture must effectively play its role of providing womblike (embryo– like) habitats for all; to provide suitable indoor environment (thermal comfort), energy must be needed. Energy use in buildings are numerous and include heating, cooling, lighting, water supply and other domestic usage such as blending of fruits and other food items, washing of dishes and cloths, ironing of cloths, floor cleaning, shaving, massaging and exercises [7].

Forms of Energy

Fossil: There are fossil fuel, which originated from organic substances such as soil, coal and natural gas. These are produced from animal and plant materials and are forms of stored solar energy that are part of our geological resource base. These are essentially non-renewable.

Other sources of energy include geothermal, nuclear, hydropower, solar and biomass etc. are referred to as alternative energy sources. The term alternative designates these as sources that might possibly replace fossil fuel in future. Many of these sources, such assolar and wind are not depleted by consumption and are known as renewable energy. As stated earlier this is truly the best source of power for all our project needs because they are inexhaustible. A list of renewable energy in very simple nomenclatures include: Solar (from the sun), ocean (from water), tidal (from wind), biomass (from plants/animal waste) Geo thermal (Earth).

Renewable Energy: Renewable energy has earlier been described as the best source of power for all our project needs (Means 2011). Renewable energy can be formed or generatedby natural process; soil, vegetation, animals, air, water are renewable primarily because they naturally undergo processes that repair, regenerate or cleanse them when their quality or quantity is reduced, Centre for Renewable and Sustainable Technology [11]. It however should be underscored that this does not mean that renewable energy sources are inexhaustible, as an over use of renewable resources can result in their reversible degradation, while non-renewable energy resources are not replaced by natural processes, or the rate of replacement is slow as to be ineffective. For example iron ore, fossil fuels and mountainous landscapes are non-renewable on human time scales. Therefore, when non-renewable resources are used up, they are gone and a substitute must be found or we must do without [15].

Energy Usage: Buildings, industries and transportation are known consumers of energy. The amount of energy consumed by countries of the world varies widely. The highly industrialized countries consume much more energy than less developed countries, this is due to climate, individual and collective consumption habit. Differences also exist in the purposes for which people use energy, while industrialized nations use energy for three purposes; Residential, commercial, industrial and transportation. Less developed nations with little industries use most of their energy for residential purposes; such as cooking and heating. Countries on transit, from less-developed to industrial economies also use large amount of energy to develop their industries [16] [18].

Residential and Commercial Energy Usage: This is of primary concern, due to the basic fact that both residential and commercial energy consumptions need the architect to provide the environment they require to function. The amount of energy required for residential and commercial use varies greatly throughout the world. For

Example about 16% of the energy used in North America is for residential purposes, while in India 20% is used. The ways residential and commercial energy is used also vary widely. In North America, 75% is used for air conditioning, refrigeration water and space heating. However in many parts of Africa and Asia much of the energy used in the house is for cooking [23]. [27] then summed up world's energy consumption thus; the industrialized countries of the world with about 20% of the world's population consume 60% of the world's electricity while less developed nations of the world which have about 80% of the world's population use 40% of world's electricity.

There are no proper documented records of energy consumption in Nigeria and most other countries in Africa, in as much as the production, distribution and documentation of electricity is a major step in the economic development of every country [29].

Energy Efficiency: There is no specific definition for energy efficient building, whether in academic studies or at national levels. Each country has different definitions and scopes for energy efficient building [3]. However an adoptable definition has Energy-efficient building as a building using energy efficient design strategies in reducing its energy usage in order to achieve lower energy consumption, these strategies includezero energy buildings, passive houses, low energy buildings, LEED buildings, green buildings, energy self-sufficient houses, plus-energy houses and any other buildings that have been specifically designed with the aim of achieving

Operational Energy: Operational energy is the energy required during the entire service life of a structure (occupancy stage) such as lighting, heating, cooling and ventilating systems; and operating building appliances. Operational energy is associated with relatively longer prolusion of infrastructure's service life and can constitute 80% to 90% of the total energy associated with the structure. However with the advent of energy efficient building system and appliances. Operational energy accounts for about 31% of primary energy consumption and 40% of CO_2 emission annually.The buildings whole life cycle consists of Operational and Embodied energy [7].

Embodied Energy: This is another element of energy efficiency building worthy of definition. Apart from the operational energy, the embodied energy in their construction and maintenance is also becoming a more significant issue. Traditionally, the construction industry has not given much consideration to the embodied energy of a building, because this is relatively insignificant compared to the operational energy for the building over its lifetime [9].

As a result, most effort has been put into reducing operating energy by improving the energy efficiency of the building envelope and educating occupants to switch off lighting and appliances when they are not in use, recent works however has shown that as the operational energy reduces steadily, the proportion of embodied energy (including energy required by maintenance becomes more significant). It is that important to note that it could take many years before the cumulated operational energy reaches the same level as the cumulative embodied energy (including energy maintenance). This is particularly true if the building is efficient and has low operation energy [13]. What then is embodied energy?

Embodied energy is the total energy required for the extraction, processing, manufacture and delivery of building materials to the building site. Energy consumption produces Carbon Dioxide, which contributes to greenhouse gas emissions, so embodied energy is considered an indicator of the overall environmental impact of building materials and systems.Unlike the life cycle assessment, which evaluates all of the impacts over the whole life of a material or element, embodied energy only considers the front-end aspect of the impact of a building material. It does not include the operation or disposal of materials.

The need therefore to reduce the embodied energy exist because the total amount of embodied energy may account for 20% of the building's energy use, so reducing embodied energy can significantly reduce the overall environmental impact of the building. Embodied energy must be considered over the lifespan of a building and in many situations, a higher embodied energy building material or system may be justified because it reduces the operating energy requirements of the building. For example, a durable material with a long lifespan such as aluminum may be the appropriate material selection despite its high embodied energy. As the energy efficiency of a building increases, reducing the energy consumption, the embodied energy of the building materials will also become increasingly important [11].

Operational Energy and Embodied Energy: It was thought until recently that the embodied energy content of a building was small compared to the energy used in operating the building over its life. Therefore, most effort was put into reducing operating energy by improving the energy efficiency of the building envelope however, research has shown that this is not always the case. Embodied energy can be the equivalent of many years of operational energy. Operational energy consumption depends on the occupants. Embodied energy is not occupant dependent — the energy is built into the materials. Embodied energy content is incurred once (apart from maintenanceand renovation) whereasoperational energy accumulates over time and can be influenced throughout the life of the building.

Forms of Sustainable Energy Buildings: The following forms of buildings are known to be energy sustainable, through their designs, construction and operations, zero energy, low to zero carbon buildings, Zero buildings, Net Zero Site energy buildings, Net Off – Site Zero energy buildings, Passive houses, low energy houses and Energy- plus houses.

Zero Energy Buildings and Low to Zero Carbon Buildings and Systems: Zero energy building (ZEB) and low to zero carbon (LZE) are general terms applied to buildings and, or systems with zero net energy consumption and low to zero carbon emission respectively.In general, the terms 'zero energy', 'zero carbon' or zero emission are applied to buildings that use renewable energy sources on site to generate energy for their operation, so that over a year the net amount of energy generated on site equals the net amount of energy required by the building [5] [6].

Zero Energy Building: A zero energy building can be defined as a building that produces as much energy on site as it consumes on an annual basis. [9] provided for definitions of ZEB, namely net zero energy, net zero source energy, net zero cost and net zero energy emission. Net Zero Site Energy building (SiteZEB) Amount of energy provided on-site renewable energy sources is equal to the amount of energy used by the building. Net Off-Site Zero Energy building (Off-Site ZEB) This is similar to Net Zero energy building situation but consider purchasing of energy off site from 100% renewable. Net Zero Source/Primary Energy Building (Source ZEB) The cost of purchasing energy is balanced by income from sales of electricity to the good of electricity generated on site. Net Zero Emission Buildings (Zero Carbon building (ZEB) Zero Emissions building.

The carbon generated from the on-site or off-site fossil fuel use are balanced by the amount of on-site renewable production.

Passive house is a rigorous, voluntary standard for energy efficiency in a building, which reduces the building's ecological footprint. It results in ultra-low energy buildings that require little energy for space heating or cooling. Buildings, schools, kindergartens and supermarkets have also been constructed to the standard. Passive design is not an attachment or supplement to architectural design, but a design process that integrates with architectural design. Although it is principally applied to new buildings, it has also been used for refurbishment.

The standard is based on five principles: airtightness, ventilation, waterproofing, heating and cooling and electrical loads. Within these principles, projects must pass building specified blower door, ventilation airflow, overall airflow and electrical load tests; buildings must also achieve other measures such as low-emission materials, renewable energy systems, moisture control, outdoor ventilation and energy efficient ventilation and space conditioning equipment.

All buildings must also pass a quality assurance and quality control test - this is implemented to ensure that the building continues to adhere to the regional criteria set forth by the PHIUS' climate data. These tests and analyses of operative conditions are performed and certified by Passive House Institute US(PHIUS) raters or verifiers. These are accredited professionals from the PHIUS that are able to perform on-site testing and inspections to ensure that the newly constructed building is adhering to the construction plans, created energy models and desired operating conditions.

Passive Solar Design and Landscape: Passive solar building design and energy-efficient landscaping support the Passive house energy conservation and can integrate them into a neighborhood and environment. Following passive solar building technique.

Low-Energy House: A low-energy house is characterized by an energy-efficient design and technical features which enables it to provide high living standards and comfort with low energy consumption. Traditional heating and active cooling systems are absent, or their use is secondary. Low-energy buildings may be viewed as examples of sustainable architecture. Low-energy houses often have active and passive solar building design and components, which reduce the house's energy consumption and minimally impact the resident’s lifestyle.

Energy-Plus-House: An energy-plus house (also called: Plus-Energy House, Efficiency-Plus House) produces more energy from renewable energy sources, over the course of a year, than it imports from external sources. This is achieved using a combination of micro generation technology and low-energy building techniques, such as: passive solar building design, insulation and careful site selection and placement. A reduction of modern conveniences can also contribute to energy savings, however many energy-plus houses are almost indistinguishable from a traditional home, preferring instead to use highly energy-efficient appliances, fixtures, etc., throughout the house.

Recommendations and Conclusion: Architects are key players to the green world development. The Nigerian architect is ahead of other professional in building professions in the race to fillingthe gap of providing housing for all. This is in active participation of Le-Corbusier (1977)’s assertion of the architect having the sole responsibility of bringing man in harmony with nature.

A green world in our contemporary living, is a sustainable development, embracing all facets of living. Sustainable architecture having been referred to as architectural movement and building circles aimed at creating structures that areenvironmental friendly and which considers in its development, energy efficiency and health of its users, there is therefore an uncompromising need for the architect on whose shoulders nature have off loaded this challenge of providing shelter for human habitation to brace up to it.

Nigerian architects are the ones to carry out this charge in their environments. A charge to key in with his contemporaries in developed nations in calling up designs, specifications and energy management practices that will put them at a common understanding. For Nigerian architects to usher in green world, they need to employ the tools at their disposal and that is sustainable architecture. Sustainable design will enable inform clients of the need for environmental elements of buildings. Recommend building orientationbe capitalized on natural resourcessuch as maximizing day lighting and good energy practices.

Architects need to develop the art of critical thinking and analysis as this will shape better their products. Critical thinking involves skills that help evaluate information, arguments and opinions in a systematic and thoughtful manner, as the level of education of some of the clients and drought of contemporary environmental information among them may slow progress.

The architect has to help with site selection based on environmental issues such as regional resources (water and renewable energy), urban infrastructure and site condition and determine the need for new buildings or remodeling of the existing. And in assisting the client in optimum team selection with specialized expertise based on project goals.

Critical thinking enable architects understand better their own opinions as well as thepoint views of others. It can help evaluate the quality of evidence, recognize bias, characterized the assumptions behind arguments, identify implications of decisions and avoid jumping to conclusions [22].

Architects in order to actualize green ideologies and sustainable concepts require clear goals and know how to apply the tools at his disposal to achieve results. He has to be research oriented and academic conscious, involving himself in contemporary issues in architecture, environmental designs and ecology.

CONCLUSION

This paper raised some issues in literature, enough to awaken the latent potentials of Nigerian architects to align with their contemporaries in developed nations in bringing to reality sustainable green world. The fact that architects products (buildings), are major contributors to the topical issue of global warming, Ozone layer depletion and climate change, the truth buildings use much energy and produces plenty Carbon dioxide should move him to imbibing modern energy practices. The result of this update will propel architectural products to live from cradle to cradle and not cradle to grave.

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