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Green Building: Imperative Panacea for Environmental Sustainability and Life Cycle Construction in Nigeria

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Abstract— **Green Building is a concept that mitigates against the negative side effects of developmental activities on the environment. This paper assessed the feasibility of green building for environmental sustainability and life cycle of construction works. Various constructions related to green building were examined. The construction materials and methods used in Nigeria today, tend to have a deleterious effect on the environment around the construction site; either by the clearing of vegetation which leads to loss of wildlife, or the use of fossil fuels such as coal; which emit greenhouse gasses. It has been discovered that lack of renewable energy harvesting plants assists in countering the effects of the depleting natural resources, as well as water/sewage treatment plants, recycling plants and so on. This do not encourage green environments as these have adverse effects on the depletion of raw materials, and this therefore helps increase the prices of newly manufactured goods. This also has adverse effects on the economy as it can lead to inflation and high demand for products. More research work should be done on this for economy of construction works, possible, implementation and sustainable environment.**

Index Terms— **Green, Commission, Building, Efficiency, Construction, Environment.**

I. INTRODUCTION

Sustainable building is the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and also reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and demolition; the complete building life cycle. Green Building is a concept that gains currency as an important mitigating measure against the negative side effects of developmental activities (Dahiru et. al. 2014).

Green building refers to both as structure and the application of processes that are environmentally responsible and resource efficient throughout a building life cycle from planning to design, construction, operation maintenance, renovation and demolition. Sustainable development can be described as that which meets the needs of the present, without compromising the ability of future generations to meet their own needs (Taiwo, 2013).

Sustainable development is the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and also reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and demolition; the complete building life cycle. Sustainable or "green building" design and construction gives the opportunity to use our resources more efficiently while creating healthier and more energy-efficient homes. These buildings leave a lighter footprint on the environment through conservation of resources, while at the same time balancing energy-efficient, cost-effective, low-maintenance products for our construction needs. There are many sources of energy that are renewable and considered to be environmentally friendly and harness natural processes. These sources of energy provide an alternate 'cleaner' source of energy, helping to negate the effects of certain forms of pollution. All of these power generation techniques can be described as renewable since they are not depleting any resource to create the energy. There are various sources of energy that can be easily adopted for a sustainable development program, such as, hydro-electricity, nuclear energy, wind energy, solar energy, geothermal energy, biofuel and ethanol hydrogen can serve as a means of delivering energy produced by various technologies. But for this study, we will focus on energy that can be domestically harvested. *Green building* (also known as *green* construction or *sustainable building*) 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. In Nigeria today, the awareness for green and sustainable development is still at the conceptual stages, the general public has little or no knowledge about green practices and the need for s self-sustaining environment.

This research assessed alternate construction materials for providing environmentally friendly materials and methods, as well as several bodies which help to monitor the exploitation of natural resources and renewable energy. Materials which help promote green should be made readily available for the public, with incentives which help to drive or strengthen the public opinion towards green construction techniques. The government of Nigeria and the Energy Commission of Nigeria should set up policies and agencies to help enlighten the public on the negative effects of the activities of the common Nigerian man, with respect to energy consumption and saving, water efficiency, waste management, recycling, and non-destructive construction practices.

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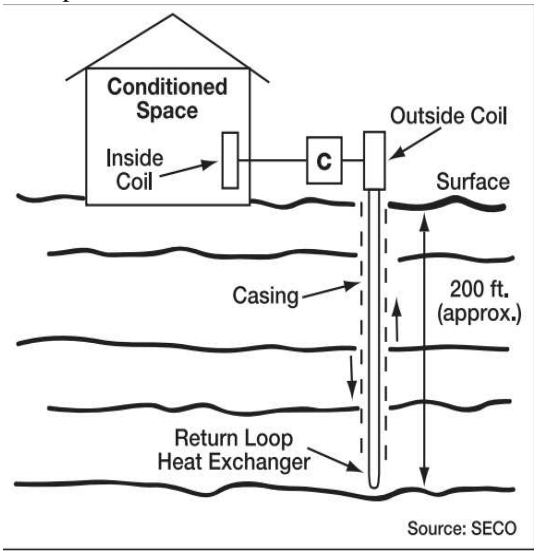
1. **Geothermal Power:** Geothermal energy is a very powerful and efficient way to extract a renewable energy from the earth through natural processes. This can be performed on a small scale to provide heat for a residential unit (a geothermal heat pump), or on a very large scale for energy production through a geothermal power plant.



A Geothermal Power Plant

2. **Wind Power**: Wind power is the conversion of wind energy by wind turbines into a useful form, such as electricity or mechanical energy. Large-scale wind farms are typically connected to the local power transmission network with small turbines used to provide electricity to isolated areas. Residential units are entering production and are capable of powering large appliances to entire houses depending on the size. It is highly dependent on wind speed. Wind turbines under 100 kilowatts cost roughly $3,000 to $8,000 per kilowatt of capacity. A 10 kilowatt machine which would be needed to power a large home, might have an installed cost of $50,000-$80,000.

Wind Turbines

3. **Solar Power**: Solar power is harnessing the suns energy to produce electricity. One of the fastest growing energy sources, new technologies are developing at a rapid pace. Solar cells are becoming more efficient, transportable and even flexible, allowing for easy installation. PV has mainly been used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array. Common residential system cost less than $3.00/W to just above $7.00/W, depending on the energy consumption in the home, therefore a house requiring 5KW of electricity would cost about $15,000 to $35,000.

An Array of Solar Panels.

II. GREEN BUILDING FEATURES

For a building to be efficient and effectively "green", all stages of construction have to be considered to ensure that the materials and methods of construction adhere to certain specifications and criteria which must be met in a green building,

Walls

There are several materials which can be used in constructing the walls of a building other than regular concrete or cement blocks, such as straw, rammed earth, glass, wood, etc.

Wood

Lumber is the primary structural component in homes. A material used for hundreds of years from log cabins to platform structures, this building technique is well understood using a renewable resource. Caution is warranted if considering timber use outside the bounds of sustainable harvesting. In extreme climates termites may be a problem or moisture failure to wood structures.

A House Made Of Wooden Walls

Straw

Straw is a natural material which can be collected from fields, they have insulation properties and they also help to control the heating of the interior of the building.

Walls Constructed with Straw

Structural Insulated Building Panel

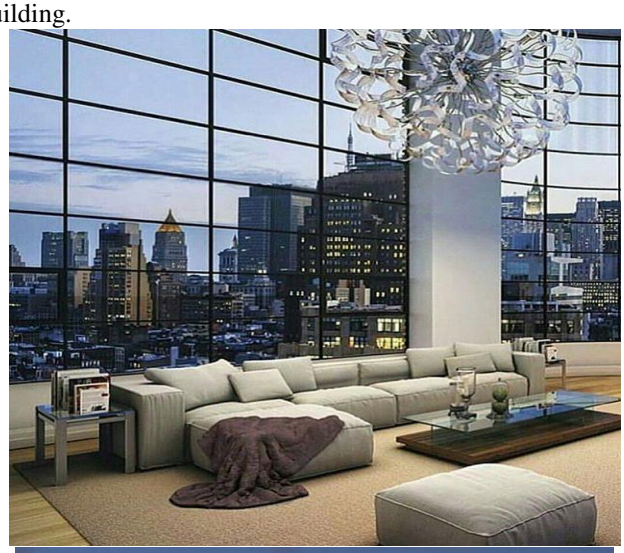
A marriage of engineered wood and foam, the building monolithic panel uses expandable polystyrene insulation, but 6 to 12 inches thick, sandwiched between two panels of oriented strand board (OSB or engineered wood panel). Both products are environmentally friendly.

Windows and doors comprise a large portion of heat loss in a wall. There are different types of windows that can be used, such as;

Wood Windows and Doors

These are high quality materials and they have along life span, they are also readily available in replacement sizes and installation.

Glass Windows and Doors and windows can also be used in buildings, to allow easy penetration of daylight into the building.



Lighting Features: When lighting a green house, the first consideration to be made is daylighting, this is done based on the design, position, siting, and angle of the house, this allows sunlight into the house during the day, therefore eliminating the need for artificial lights during the day, then at night solar powered energy saving bulbs can be used to ensure low energy consumption for lighting features, when there is a large budget for the project, motion sensitive lights can also

be used, therefore when a room is not in use, the lights automatically trip off to save power, and when someone walks in, they trip on. Dimmers can also be used to reduce the intensity of the light, this also helps to save energy, some types of light bulbs that can be used are; Compact fluorescent lamps (CFLs), and Light-emitting diodes (LEDs). There are a lot of great translucent insulating building products which will allow you to let light into your home without letting heat in or out. You can maximize the light in a given room by choosing light colours and reflective materials for your walls, ceiling and floor.

Motion sensitive light bulbs and energy saving bulbs

Roofing

Eco-friendly roofing products typically cost more than conventional roofs, but they last two to three times longer, saving you substantially over the long term. These benefits add value to your home, whether you stay there or sell it, and you're also helping promote a healthier, more sustainable world.

Brown Roofs:

Brown roofs, also known as biodiverse green roofs are a type of vegetated roof system designed specifically to provide a biologically diverse habitat for plants, animals, and insects. Brown roofs are installed in essentially the same way as green roofs but their growing medium is composed of recycled building materials, soil, and spoil from the site.

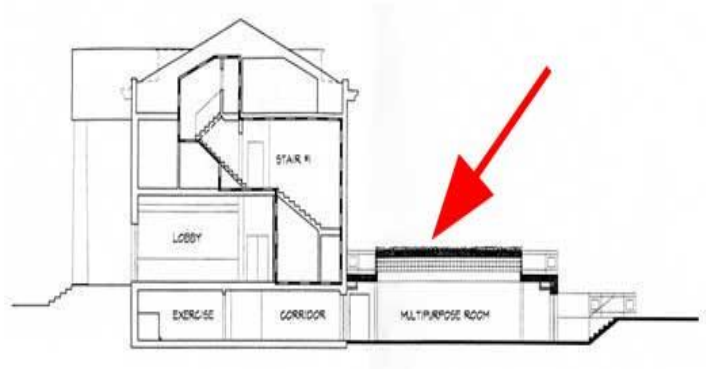
Cool Roofs

A cool roof is an alternative "green" roofing treatment that can also be used on buildings with flat roofs as well as on some with roofs that are too steeply sloped for plant material. A cool roof has roofing material with a high reflectance to reflect heat. They are measured by their *solar reflectance* and the *thermal emittance* (the ability of the roof surface to radiate absorbed heat).

The White Coating Helps to helps keep the interior temperature down by reflecting solar energy

Ground Level Green Roofs

A green roof does not have to be high above ground to be beneficial. Green roofing systems can be installed at ground level in a courtyard or as part of a terrace above an underground parking garage or other structure. A ground level green roof appears as a site feature continuous with the existing landscape.



Combining Green Roofs, Cool Roofs, and Solar Installations

A green roof can also be supplemented with other sustainable features, such as a cool roof or solar panels. Combining a green roof and solar panels may actually benefit both installations. Lower roof temperatures that result from a green roof help to boost the efficiency of solar panels, which operate less efficiently at extreme temperatures.

Recycled Shingles

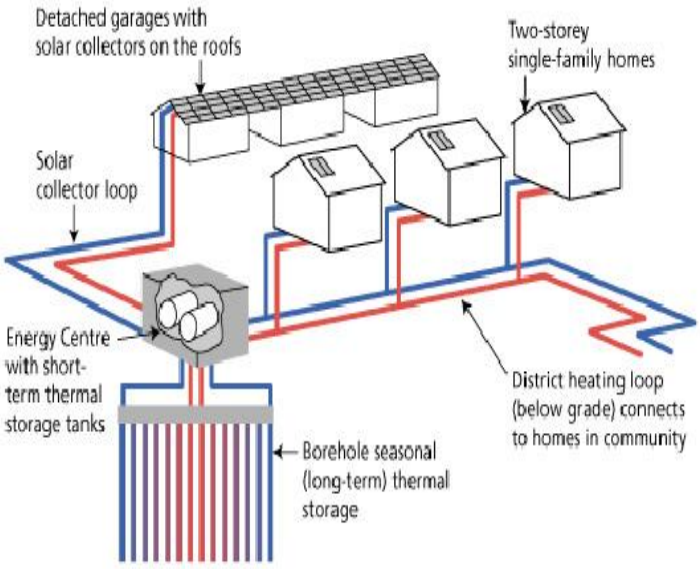
Roofing shingles made from recycled waste materials, such as plastic, rubber, or wood fiber. Recycled-content shingles are durable, and beautiful. Recycled-content roof shingles help divert waste from landfills and reduce our need to extract and process raw materials, which lowers energy consumption and reduces pollution.

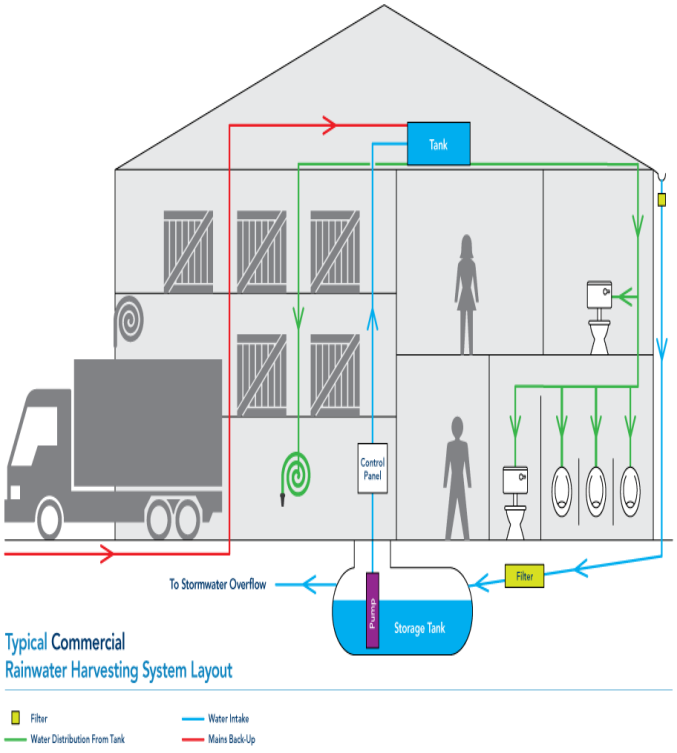
Air Conditioning: Energy conservation, indoor air quality, and comfort are among the core green building issues encompassed by heating, air-conditioning and ventilation design. These interrelated systems can be complex, expensive to install, and costly to operate but green building also offers many opportunities to simplify and save costs in the long run. Central to this premise of thinking small are the many passive solar features built into a green house. HVAC design follows other fundamental building steps that can collectively reduce the size of the heating and cooling system by 30-50%. Solar orientation, insulation, window placement and design, even vegetation on the building site all directly affect heating and cooling loads. Designing a system based on real demand, not conventional practice, is essential. Therefore it is essential to incorporate this system at the design of the house, so as to fully account for all other components which can help to reduce the size of the air conditioning system required.

Water Supply Systems: Water efficiency is the smart use of our water resources through water-saving technologies and simple steps we can all take around the house. As residential, commercial, industrial, and other development expands, so does the use of the limited potable water supply, water that is suitable for drinking. Most buildings rely on municipal sources of potable water to meet their needs, from flushing toilets to washing dishes and landscape irrigation. High demand strains supplies and under extreme conditions necessitates water rationing. Furthermore, large amounts of wastewater can overwhelm treatment facilities, and the untreated overflow can contaminate rivers, lakes, and the water table with bacteria, nitrogen, toxic metals, and other pollutants. To avoid this damage to the ecosystem, additional municipal supply and treatment facilities must be built, at public cost.

In developed communities, water is supplied to all homes from a central storage through pipes laid underground, which can either be plastic or steel pipes. These pipes help to supply clean water to these houses as well as take away waste water and sewage back to the treatment plants.

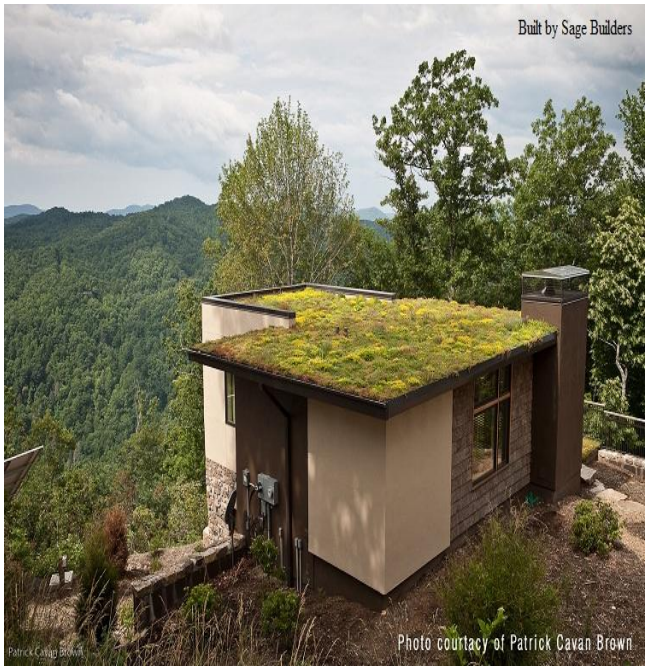
Also houses with treatment facilities can utilize rainwater by harvesting it and treating it before circulating it for house use.





III. ARCHITECTURAL DESIGNS OF GREEN BUILDINGS

Green buildings are designed with several considerations such as access to social amenities such as water, power, transport, as well energy consumption, angle of sunlight, maximizing land use, etc.



A. COMPONENTS OF GREEN BUILDING

Some strategies for reducing the environmental impact of construction are classified below under the basic elements of green buildings.

1. **Sustainable Site Design**: Sustainability means creating places that are environmentally responsible, healthful, just, equitable, and profitable. Some strategies that help in siting include;
   - Reduce urban sprawl and destruction of valuable land, habitat and green space.
   - Preserve key environmental assets through careful examination of each site.
   - Engage in a design and construction process that minimizes site disturbance and which values, preserves and actually restores or regenerates valuable habitat, green space and associated eco-systems that are vital to sustaining life.
2. **Energy Efficiency and Renewable Energy**: Energy efficiency means an improvement in practices and products that reduce the energy necessary to provide services. Energy efficiency products essentially help to do more work with less energy Some strategies that help to reduce energy use include;
   - Solar Design: Solar design uses the sun's energy for the heating and cooling of living spaces.
   - Daylighting – Use of daylighting so that during the day natural light provides effective internal lighting.
   - Use of solar water heating systems.
3. **Water Efficiency**: The demand for water is ever increasing, therefore it is very essential to use available water efficiently. Managing the consumption of water is one of the major factors of green building.
   - Designing dual plumbing that recycles water in toilet flushing or by using water for washing of the cars.
   - Minimize waste water by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow shower heads.
   - Portable water purification devices or Point of use water treatment and heating improves both water quality and energy efficiency
   - Using water management methods like rainwater harvesting and gray water irrigation and storm water management.
4. **Materials Efficiency**: Designing with industrial materials and recycling Construction and Demolition (C&D) materials generated from projects leads to more sustainable buildings.
   - Develop and implement ways to reduce the amount of materials used and waste generated through the implementation of a construction waste minimization plan.
   - Use of re-usable, renewable, non-toxic and recyclable building products.
   - Use salvaged building materials.
5. **Indoor Air Quality**: Indoor air quality is a term which refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. Indoor Air Quality aims to reduce chemicals like volatile organic compounds.
   - Use building materials and products that do not contain or release VOCs.
   - Choose construction materials and products with zero or low VOC emissions during the design and construction process to improve IAQ.
   - Provide a smoke free building.
   - Ensure adequate Ventilation systems
   - Plants in the house also aid in ventilation.

IV. THE NEED FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

Creating sustainable working environments is not just about reducing carbon emissions. Truly sustainable buildings should be designed to improve the wellbeing of the people who work in them and the communities that surround them.

"Going green" is the phrase referring to corporate and individual action consciously taken to curb the harmful

effects on the environment through consumer habits and lifestyles.

Access to clean modern energy services is an enormous challenge facing the African continent because energy is fundamental for socioeconomic development and poverty eradication. Today, 60% to 70% of the Nigerian population does not have access to electricity (Oyedepo, 2012). Security, climate change, and public health are closely interrelated with energy (Ramchandra, 2011). Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly.

The common Nigeria man does not understand the concept of "conservation of energy" and this is the guiding principle behind sustainability. That every home should be able to utilize energy, either water, air, electricity, etc. conservatively, without causing harm to the environment. The recent world's energy crisis is due to two reasons: the rapid population growth and the increase in the living standard of whole societies. The per capita energy consumption is a measure of the per capita income as well as a measure of the prosperity of a nation (Rai, 2004). Energy supports the provision of basic needs such as cooked food, a comfortable living temperature, lighting, the use of appliances, piped water or sewerage, essential health care, educational aids, communication and transport. Energy also fuels productive activities including agriculture, commerce, manufacturing, industry, and mining.

At present, environmental protection dominates as the primary objective of sustainable development (Anigbogu, 2014).

In Nigeria today, most structures are constructed using cement based materials. Cement during its manufacture and use is responsible for the emission of greenhouse gasses which are harmful to the environment. The production of cement also causes the depletion of non-renewable natural resources. The incremental rate of construction has pervaded most urban centres in Nigeria, with most of such buildings inhabited with the barest facilities in place (Olufunto and Olatunde, 2013).

Architects, planners, environmentalists and engineers should be oriented on issues such as energy consumption, use of environmental friendly materials and design concepts that reduce environmental impacts and ensure sustainability.

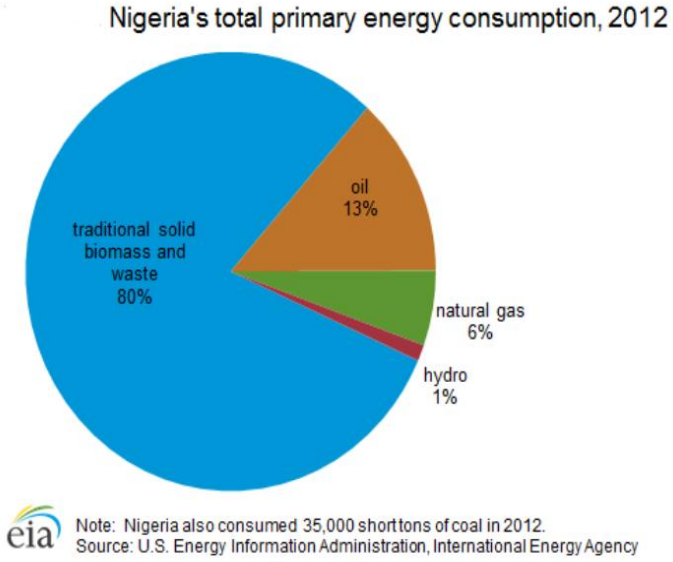
Energy and poverty reduction are not only closely connected with each other, but also with the socioeconomic development, which involves productivity, income growth, education, and health (Nnaji C et al, 2010).

There are various problems which must be overcome before Nigeria can truly have a sustainable environment, some of them are talked about below.

A. *ENERGY SUPPLY*

Nigeria is the largest oil producer in Africa and is among the world's top five exporters of Liquefied Natural Gas. Despite the relatively large volumes of oil it produces, Nigeria's oil production is hampered by instability and supply disruptions, while the natural gas sector is restricted by the lack of infrastructure to monetize natural gas that is currently flared.

It's important to note that estimates of traditional biomass consumption are imprecise because biomass sources are not typically traded in easily observable commercial markets. The electrification rate in Nigeria is estimated at 41%, leaving approximately 100 million people in Nigeria without access to electricity (U.S. Energy Information Administration).



Industry operators can play a significant role in the development and use of clean energy. Simple solutions such as the use of modular solar-powered generating plants, or use of fossil fuels or bio gases will make a big difference. Nigeria is also reported to have over 60 million generator sets.

The responsibilities of strategic planning and coordination of national policies in the field of energy, rest with The Energy Commission of Nigeria. The ECN was established by Act No. 62 of 1979, as amended by Act No.32 of 1988 and Act No. 19 of 1989 (Energy Commission of Nigeria).

B. *WASTE MANAGEMENT*

There have been very little done by successive governments or relevant agencies with regards to environmentally sustainable waste disposal. Indiscriminate dumping of waste by individuals and government agencies is rife. Only in the past couple of years has the Lagos State Government developed and is implementing a waste management strategy. LAWMA has drastically helped to manage the disposal and transportation of waste in the state.

C. *DESIGN AND BUILDING INNOVATION*

This requires special attention to extending green building to the many areas in Nigeria facing shortages in affordable housing, including those with climatic conditions or other circumstances that present unique challenges. Construction is a major and primary sector of the Nigerian economy and its consideration of the issues of sustainability covers a huge spectrum of the sector (Nwafor, 2006). Thus, the role buildings play is fundamental to the realisation of sustainable development. The specific problem of creating sustainable shelter in sustainable human habitats is visible in both rural and urban centres of developing countries.

Although sustainability is fast assuming a global trend, the position of architecture in actualizing the sustainable development goals in developing countries is not encouraging (Olufunto and Olatunde, 2013).

FRESH WATER AND SEAWAGE

Most communities in Nigeria do not have access to hygienic, portable water, this has adverse effects on the occupants of such communities. Meanwhile communities and households with access to water do not usually adhere to the concept of conservation. Nigeria does not have basic plans for sewage and waste water treatment. These should be provided around the country to help reduce the amount of waste water and aid recycling, as well as provide means of distributing water to the rural communities.

D. COMPARING COSTS FOR GREEN AND CONVENTIONAL BUILDINGS

This analysis compares the cost for a three-bedroom house, built with conventional materials, and to one built with sustainable materials. These costs involve the costs of labor and materials.

ACTIVITY	GREEN BUILDINGS (₦)	CONVENTIONAL BUILDINGS (₦)
Sub Structure	2,634,300.00	2,176,080.00
Insulation	850,000.00	
Doors	444,900.00	1,187,740.00
Windows	714,000.00	1,020,030.00
Concrete Works		1,229,500.00
Reinforcements and formwork		518,550.00
Blockwork		509,550.00
Walls		3,202,000.00
Roofing, Fascia	2,034,900.00	1,910,385.00
Lighting Fixtures	459,600.00	204,450.00
Wiring	1,140,300.00	1,800,000.00
Fittings (Cabinets, etc.)	1,955,700.00	719,160.00
Heating and Cooling Systems	892,200.00	
Plumbing Fixtures	2,774,100.00	11,443,080.00
Floor, Wall And Ceiling Finishing, Painting	1,995,000.00	2,904,940.00
TOTAL	18,799,300.00	30,491,995.00

The cost analysis for the conventional building was gotten from Proposed Guest House at Regional Centre for Aerospace Survey (Rectas), Obafimi Awolowo University, Ile – Ife, Osun State., while the analysis for the green building was gotten from www.costbuilding.net.

The conversion of foreign currencies from Dollar to Naira, was done at the rate of 300USD to 1 NAIRA.

DEVELOPING A GREEN AGENDA FOR NIGERIA

The essence of this framework is to suggest how sustainable construction can be achieved. It is advisable that Environmental impact Assessment (EIA) should be carried out during the planning and design stages of projects, provided that the traditional EIA is expanded to include assessment of all four `indicators of sustainable construction.

Renewable energy has an important role to play in meeting the future energy needs in both rural and urban areas. The need for sustainable energy is rapidly increasing in the world. A widespread use of renewable energy is important for achieving sustainability in the energy sectors in both developing and industrialized countries.

Nigeria is blessed with a large amount of renewable natural resources, which, when fully developed and utilized, will lead to poverty reduction and sustainable development. Renewable energy generally has less environmental impact than other energy sources. The implementation of renewable energy technologies will help to address the environmental concerns that emerged due to greenhouse gas emissions such as carbon dioxide (CO2), oxides of nitrogen (NOx), oxides of sulphur (SOx), and particulate matters as a result of power generation from oil, natural gas, and coal (Oyedepo, 2012).

Government regulations and programs and policies, play a very crucial role in driving the market towards sustainability goals. These programs should be based to a large extent by the desire to reduce the construction material wastage, save energy and water costs and to improve living and working conditions. The Nigerian government has set up several policies and regulations to help monitor the construction of structures in the country, in order to safeguard the environment. The prevailing laws within the built environment include: Federal Environmental Protection Agency Act of 1988 (FEPA Act), National Policy on the Environment (NPE) 1989 and Environmental Impact Assessment Act of 1992 (EIA Act). The Federal Ministry of Environment (FME) administers and enforces environmental laws in Nigeria (Nwokoro and Onukwube, 2011). The approach of regulatory agencies is the prevention of environmental damages, the regulation of potentially harmful activities and the punishment of wilful harmful damage whenever this occurs.

It is critical that all policies and programs related to sustainable building be integrated with comprehensive urban development programs geared toward development of sustainable communities, with emphasis on integrating green building with sustainable urban infrastructure for transportation, gas and electric utilities, potable water, waste disposal and recycling, storm water and wastewater

management and sewage.

A legal, administrative, and financing infrastructure should be established to facilitate planning and application of renewable energy projects. Government must play a useful role in promoting renewable energy technologies by initiating surveys and studies to establish their potential in both urban and rural areas (Oyedepo, 2012).

Research carried in Nigeria with respect to alternative construction materials and secondary construction materials over three decades contributed greatly towards increasing sustainability principles (Anigbogu, 2014).

To seize the opportunities presented by renewable energy resources in sustainable development, Nigeria needs to establish renewable energy markets and gradually develop technology to harness renewable energy (Oyedepo, 2012).

A typical green building

E. THE GOALS OF GREEN BUILDING

Now, we should consider the goals of green building. Of course, one of the main goals is to make the earth more sustainable, but it really does go deeper than that. When you decide to go green, your goal will be to actually help to sustain the environment preventing disruption to the natural habitats around it.

Some examples of sustainable building goals are:

- Reduction in water consumption
- Reduction in energy consumption
- Infill development
- Affordability
- Improved indoor air quality
- Use of more sustainable materials
- Reuse and recycling

There are a number of features which can make a building 'green'. These include:

- Efficient use of energy, water and other resources
- Use of renewable energy, such as solar energy
- Pollution and waste reduction measures, and the enabling of re-use and recycling
- Good indoor environmental air quality
- Use of materials that are non-toxic, ethical and sustainable
- Consideration of the environment in design, construction and operation
- Consideration of the quality of life of occupants in design, construction and operation
- A design that enables adaptation to a changing environment

Any building can be a green building, whether it's a home, an office, a school, a hospital, a community centre, or any other type of structure, provided it includes features listed above.

F. BENEFITS OF GREEN BUILDING

With innovative technologies persistently being developed to complement current practices in creating greener structures, the benefits of green building can range from environmental to economic to social. By adopting greener practices, we can take maximum benefit of environmental and economic performance.

There are three main focus points when trying to achieve sustainability,

Services	Equity	Biodiversity
Household Needs	Participation	Natural Resources
Industrial Growth	Empowerment	Carrying Capacity
Agricultural Growth	Social Mobility	Ecosystem Integrity
Efficient Use of Labor	Cultural Preservation	Clean Air and Water

The trifocals of sustainable development

Source: adapted from http://www.worldbank.org/depweb/english/sd.html

Environmental Benefits:

- Reduce wastage of water
- Conserve natural resources
- Improve air and water quality
- Protect biodiversity and ecosystems

Economic Benefits:

- Reduce operating costs
- Improve occupant productivity
- Create market for green product and services

Social Benefits:

- Improve quality of life
- Minimize strain on local infrastructure
- Improve occupant health and comfort

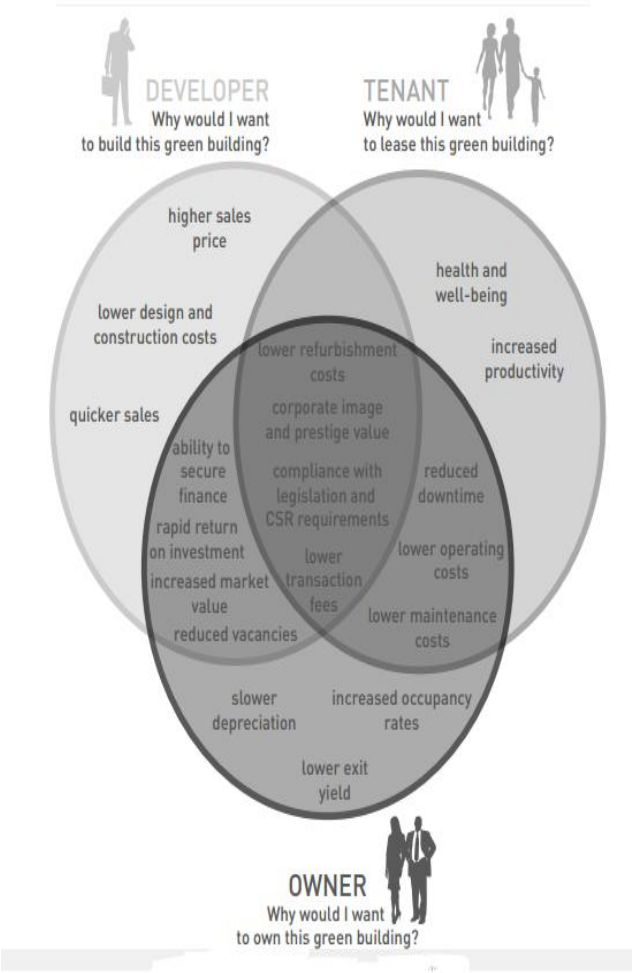


Figure 2: Benefits of green buildings

G. ECONOMIC AND FINANCIAL CONSIDERATIONS OF GREEN BUILDINGS.

While there can be an additional cost associated with building green, the cost premium is typically lower than is perceived (World Green Building Council, 2013). Building green does not necessarily need to cost more, particularly when cost strategies, program management and environmental strategies are integrated into the development process right from the start.

While the environmental benefits of green buildings have been firmly established, green buildings also deliver a range of compelling financial and social benefits (World Green Building Council, 2013). Green buildings have been shown to save money through reduced energy and water use and lower long-term operations and maintenance costs (World Green Building Council, 2013).

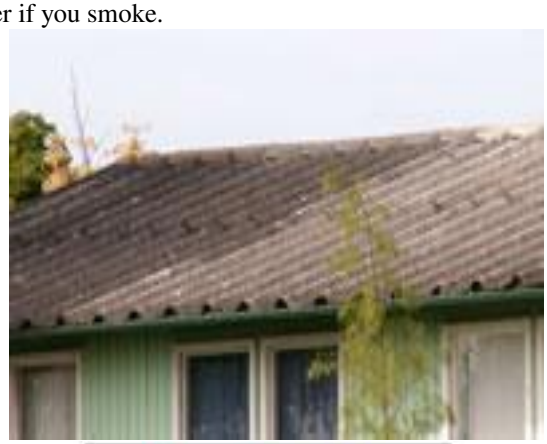
A lack of access to energy contributes to poverty and deprivation and can contribute to the economic decline.

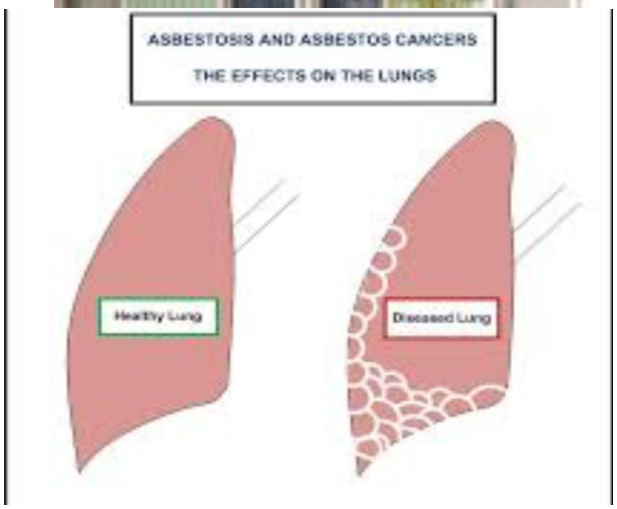
HEALTH AND ENVIROMENTAL IMPACTS OF GREEN BUILDINGS

Environmental sustainability recognises that human activity over time and the health of the environment are interdependent and that environmental health has necessary social, political and economic determinants. Research shows that the green design attributes of buildings and indoor environments can improve worker productivity and occupant health and well-being, resulting in bottom line benefits for businesses.

The U.S. Environmental Protection Agency defines Sick Building Syndrome (SBS) as "situations in which building occupants experience health and comfort effects that appear to be linked to time spent in the building and which lessen after leaving the building" (US Environmental Protection Agency, 1991). Symptoms typically characterizing SBS include, headache, eye, nose, or throat irritation, dry cough, dry or itchy skin, dizziness and nausea, difficulty in concentrating; fatigue, and sensitivity to odours.

Breathing in asbestos fibres can cause asbestosis, lung cancer and mesothelioma. The risk of contracting these diseases increases with the number of fibres inhaled and the risk of lung cancer from inhaling asbestos fibres is also greater if you smoke.





An asbestos roof Growth of lung cancer caused by asbestos

ASSET VALUE AND REAL ESTATE

As investors and occupants become more knowledgeable about and concerned with the environmental and social impacts of the built environment, buildings with better sustainability credentials enjoy increased marketability. Green buildings are able to more easily attract tenants and to command higher rents and sale prices.

In markets where green has become more mainstream, there are indications of emerging 'brown discounts', where

buildings that are not green may rent or sell for less (World Green Building Council, 2013). Sustainability risk factors can significantly affect the rental income and the future value of real estate assets, in turn affecting their return on investment. Nigeria is currently witnessing a construction boom owing to rapid urbanisation and the increased housing and infrastructure needs of a growing population. This need can be harnessed by property investors.

The social benefits of green buildings will exceed the benefits to private property owners, given that carbon emissions and other pollution are costs which are not currently factored into prices, which is another important reason why the uptake of green buildings will be less than is desirable.

ALTERNATE MATERIALS USED IN GREEN BUILDINGS

There are various materials and methods used in the construction of green buildings, the selection of these materials are based on some criteria, such as;

- Aesthetic Quality
- Durability
- Ecological Impact
- Embodied Energy
- Performance
- Social Impact
- Cost

Green building materials can be grouped based on their uses and functions such as;

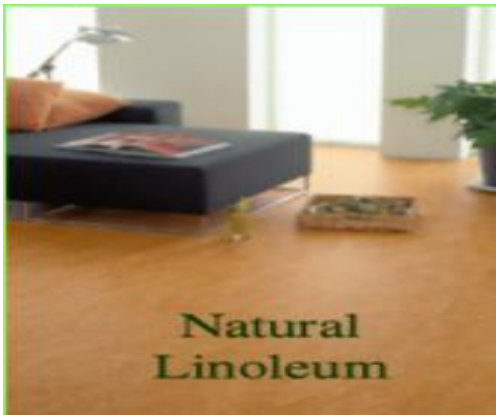
- Flooring
- Wall Finishes
- Cabinetry
- Solid Surfaces
- Tile
- Insulation

FLOORING

The materials used as alternatives to wood and can be grouped as follows;

- Rapidly Renewable Flooring

Eucalyptus



Natural Linoleum

- Waste Based Flooring

Recycled Aggregate Flooring

Cork Reclaimed & Forest Salvaged Woods

- Sustainable Carpeting

Wool *Sisal* *Sea Grass*

- FSC Certified Flooring

SOLID SURFACES

There are other bodies that help to certify alternate materials use in green buildings such as;

- SFI (Sustainable Forestry Initiative); Funded and dominated by the timber industry
- CSA (Canadian Standards Association)
- PEFC -Program for the Endorsement of Forest Certification
- ISO (International Standards Organization)
- IBAMA; Program of the Brazilian government

Other materials that can be used for green buildings are

1. Wool bricks

They were developed by Spanish and Scottish researchers. They added wool fibres to the clay material used to make bricks and combined these with an alginate, a natural polymer extracted from seaweed.

Wool bricks

2. Solar tiles

Unlike most solar units which are fixed on top of existing roofing, solar tiles are fully integrated into the building, protecting it from the weather and generating power for its inhabitants.

Solar tiles

3. Paper insulation

It is made from recycled newspapers and cardboard, paper-based insulation is a superior alternative to chemical foams. Paper is naturally flammable and this means that if it is not treated it could prove a fire hazard, therefore being treated with a fire retardant is an important part of the process. It is also treated with insecticides.

Paper insulation

4. Triple glazed windows

Energy efficient triple-pane windows are quieter and more comfortable than double-pane, and they save some money. The space between the panes is filled with krypton gas. Low-emissivity coatings are applied to the glass, further preventing heat from escaping.

Triple glazed windows

5. Rock

Rock is a great alternative to conventional materials which contain chemicals that may be harmful to people, pets or the

environment. Rocks have two great characteristics: good thermal mass and thermal insulation. These help to keep the temperature in the house.

Rocks

6. Straws

Straw bales can be used as a basis for walls instead of drywall. Straw provides excellent insulation and fire resistance in a traditional post-and-beam structure, where a wood frame supports the house. These straw walls are about 75% more energy efficient than standard drywalls and because no oxygen can get through the walls, fire cannot spread and there is no chance of combustion.

Straws

7. Papercrete

Papercrete is an interesting and very new material that is a good substitute for concrete. Papercrete is shredded paper, sand, and cement mixed together that forms a very durable brick-like material. Buildings utilizing papercrete are very well-insulated as well as being termite and fire-resistant. Papercrete is very cheap.

Papercrete

8. Sawdust

Sawdust is a good material to combine with clay or cement mixtures and use for walls. Sawdust may be combined with water and frozen to produce a material commonly known as pykrete, which is strong, and less prone to melting than regular ice.

V. RECOMMENDATION AND CONCLUSION

Green buildings and sustainable development should not be totally dependent on the government, private sectors can also play a role in this agenda, as well as the community generally. The development of green infrastructure as an alternative to traditional construction methods in Nigeria would be the best to curb the deleterious environmental impact of construction by the efficient and moderate use of materials, energy, and development space. Raising the public profile of green construction, is a large part of the education and knowledge-sharing process, tackling biases, both in terms of knowledge and also against particular technologies or building design approaches. There is a need to strengthen the capacity of the construction sector to design and build green buildings. Due to the increase in the number of quacks and unlicensed personnel, there is a lack of appropriately trained professionals and skilled labor. The government should also help set up developed markets for energy and resource efficient technology, skills and materials. Finance for green construction, including materials supply, should also be made readily available to potential investors. Cheap materials can be gotten from recycled products, therefore recycling plants should also be setup to aid reuse of materials and this in turn helps create jobs.

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