RESEARCH ARTICLE OPEN ACCESS

Sustainable Energy Resource Buildings: Some Relevant Feautures for Built Environment Needs In Nigeria

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Abstract
Energy has become a critical issue in national and global economic development. Its crucial importance to the nation's building makes the development of energy resources one of the leading agenda of the present democratic government of Nigeria, towards lifting the nation to the comity of twenty (20) nations with the fastest growing economy in 2020. In achieving this, the building industry and in particular the architectural profession has a leading role to play in adopting education, designs, materials, and technology capable of reducing energy consumption in building within tropic region. This paper, therefore, appraises the important features of energy performance building through the use of sustainable innovative materials and technology that respond to climate condition while being environmentally friendly.

Keywords: sustainable; energy resource building; materials; technology and climate

I. INTRODUCTION

Sustainable development entails that resources are optimally used by present generation without jeopardizing the future for yet unborn. While man extracts matter and energy from the environment, he also gives something in return. thus, his impact on the environment in any area depends on the magnitude , rate and manner of his extraction of resources and magnitude rate and quality of the feedback.

An important element in each case is the production and management system adopted and this is very important because it largely determines the extent to which man can capitalize on the ability of many natural resources (e.g. wood) to replenish and maintain themselves. It entails using resources to achieve greatest good for the largest number for the largest possible time.

This call for the new effort at maximizing the usage of some of the building materials for enhanced environment.

The era of ample and cheap fossil is fast ending,making energy to become a critical factor in national and global economic development. The sumptuous use of energy to create interior condition and lighting to create interior comfort condition and lightings that largely ignore the natural environment is no longer fashionable. The architecture of nowadays should be more responsive to environmental factors and much less dependent on ever more valuable fossil fuels. This energy design or energy conscious design can be achieved through intelligent design and use of material technology.

1.1 Literature Review

Building energy consumption amount to about one-third of the current annual fossil fuel consumption in the United States.Since it is possible to reduce consumption by 50 percent or more with recent practices design and construction, it will affect the existing stock of the buildings, many of which are true energy glutton (synder and catanese, 1979).

The sun is the driving force behind all climate and life forces on the earth. (Synder and catanese, 1979) opines that the transfer of energy at macro level begins when incoming solar energy strikes the outer level atmosphere or building envelope. About 30 percent of this energy is reflected back in to space by atmosphere and clouds. About 20 percent is absorbed by water vapour , dust and water droplets in the lower troposphere. The remaining 50 percent is absorbed by the earth's liquid and solid surfaces. It is the outward movement of this energy from the earth's surface by long- wave radiation,conduction and lateral energy flow in the form of water vapour that begins the dynamic climatic process of the atmosphere. Greater technical proficiency, in the areas of site climate, thermal comfort, heat gain and loss, innovative and alternative energy system and building economics, is now impressive.

The building Energy Corporation of United States observes that building should be designed, built, renovated or re-used to be environmentally responsible and economically beneficial, it should provide healthy living and work space. Sustainable energy,a key to element of green buildings is clean, renewable, reliable and unlimited. Architects training should include this knowledge area.

Energy efficient buildings reduce the amount of electricity required and used electricity more cost-effectively. A good building design and envelop protect the interior from external elements such as moisture and temperature, and prevent leakage of heat or cooled air from the building.

Site energy generation through energy sources that constantly renew themselves are practically inexhaustible- the sun and wind. Proper harmonization of these in to building designs and the use of photovoltaic and thermal solar energy sources.

Therefore, this paper will try to explain some important features of sustainable energy resources buildings, which are relevant for the present development needs of Nigeria. It is expected that proper knowledge of these features amongst practicing, architects, will not only constitute increased adequacy of professionalism to build environment needs but also will influence architecture schools' curricula review and adaptation.

1.2 PROBLEM

Most buildings are constructed with non-renewal materials there by contributing to the depletion of the earth's resources. The buildings also contribute to the earth's pollution due to the un-recyclable nature of the materials they are constructed with. it is in this view that a critical look into the architecture is carried out to avoid this problem and provide satisfactory solutions.

1.3 METHODOLOGY OF THE STUDY

The required data was obtained from Case Study on Somebuildings and the information wereanalyzed to make recommendations or adopt design to achieve a better environmental quality.

1.4 AIM AND OBJECTIVES

The aim of this paper is to explain some important features of sustainable energy resources buildings, which are relevant for the present development needs of Nigeria. It is expected that proper knowledge of these features amongst practicing, architects, will not only constitute increased adequacy of professionalism to build environment needs but also will influence architecture schools' curricula review and adaptation.

- To avoid depletion ofresourcessuch asraw materials,water and energy.
- To avoid environmental degradation caused byfacilities and infrastructure throughout their life cycle; and build, buildings that are inhabitable,comfy, safe, and productive.

1.5 QUESTIONS

What is the energy efficiency of a building?
Why is energy efficiency in buildings important?

II. Design and material strategies

Strategies for achieving energy efficiency in buildings could be through design, materials and application of technology initiatives that are responsible to climate conditions. In semi-arid regions of tropical Africa.Especially northern Nigeria. The climate is characterized by a long dry season associated with cool and dry hermattan wind, high temperature range and intense sunlight (olotuah,2001). The indigenous architecture adopts the use of massive earthen materials in wall construction;Minimum opening's for ventilation and circular house form as solution to enormous solar heat. Softly rounded curvilinear surfaces and rough textures of earthen walls cause sunrays to be diffused on reflection by the wall, and harsh glare is thus eliminated. The use of earthen materials ensures cool interiors in the hot afternoon and warm interiors during cold nights. This mud, which has a very high heat storage capacity, takes considerable time to cool down.it absorbs heat slowly in the afternoon and dissipates it slowly at night. Mechanical cooling equipment can thus be completely avoided in buildings of this type.

In hot-wet tropical climates in sub-equatorial rainforests in southern Nigeria high temperatures and humidity are experienced. The two main requirements necessary for physiological comfort of the occupants are thermal insulation and cross ventilation. Intense solar radiation leads to an increase in temperature, which results in an increase in relative humidity of the atmosphere.

Cross ventilation is thus necessary to ensure comfort of the occupants of the buildings. Thermal insulation prevents the hot tropical sun from heating up the room interior to avoid making them uncomfortable. With the use of appropriate construction materials and technology, less mechanical dependent building that are energy resourceful are achieved and thus reducing carbon dioxide in the building (Olatuah, 2007).

In the temperate regions appropriate design and technology could be used to reduce the need for fossil-fuel energy. These strategies can dramatically reduce the home's need for fossil-fuel energy. Conceptually, in temperate climates, the Northern Hemisphere, a good rule to follow is to make the building small to the high summer sun and large to the low winter sun. The relative emphasis on summer cooling or winter heating needs will modify this dictum according to the local climate. The orientation of the building should vary with its micro climatic factors in order to gain maximum benefit from natural cooling and heating technique. A more elaborate method of defining climatic zones are capable of forging scientific relations between the climate and building design but this environmental determinism is achieved through ever increasing

complexity, thus making it possible to delineate climatic design zones (Ogunsote and Ogunsote, 2002).

2.1 Insulation

Effective insulation method of walls, roofs and floors is another strategy to improve energy efficiency of building. Insulation prevents heat transfer from the indoor and outdoor environments and can greatly reduce monthly utility bills. It is usually measured in R-values and the higher the R-value, the greater the resistance to heat transfer.There areusually two types of insulation: bulk insulation and reflective insulation. Within the tropics, reflective insulation put inbeneath roof fabricis very effective because it does not entice heat within the building. However bulk insulation is additional effective at preventing loss of cool air from the building then improves the efficiency of air-conditioning. Insulation that absorbs wetnessought to be avoided as this may become musty in the tropical surroundings. Ventilating the ceiling cavity also canfacilitate to dry the area out, reducing the possibilities of mold growth.

Types of insulation

- Reflective insulation primarily resists radiant heat flow attributable to its high reflectivity and low ability to re-radiate heat and is more practical once put in with air layer next to the shiny surface. As a result of it works via reflection, the thermal resistance of reflective insulation varies with the direction of heat flow through it unless it's designed to be reflective on either side. Reflective insulation is typically shiny aluminum foil laminated onto paper or plastic and is offered as sheets (sarking), concertina-type batts and multi-cell batts. Concertina batts and multi-cell battseven have a tiny low resistive capability and thus have a better R value thansarking.

FIG.1.ALLUMINIUM FOIL INSULATION SHEET.

- Bulk insulation in impact acts as thermal mass and resists the transfer of conducted and convected heat by counting on pockets of trapped air at intervals its structure. Its thermal resistance is basically a similar not with standing the direction of heat flow through (i.e. in or out of the building). Bulk insulation includes materials like glasswool, wool, cellulose fiber, polyester and styrene. The R value of the product varies according to material and thickness.

FIG.2.BULK INSULATION

FIG.3.BLOWING CELLULOSE IN TO RAFTER BAYS.

FIG.4. EARTHWOOL BULK INSULATION INSTALLED ON WALLS.

2.2 Material Selection and Embodied Energy

The type of materials used in the construction of a building will to a large extent determine the comfort or otherwise of the building. This Folorunso (2005), observes that makes appropriate choice of materials a great task. Archeampong (1988), agrees that the housing industry in Nigeria is weather-sensitive; hence its development may gain by taking into account meteorological factors. The diverse climatic conditions of the tropics, perhaps, led the early people to understand the different properties of building materials with desirable properties to modify climatic extremes and adjust to the climatic environment. Human comfort varies with weather conditions; even when buildings have efficiency constructed, there is often need for artificial heating and cooling.

Operation energy is the main energy consumed by buildings. Embodied energy of materials that compose buildings is however, an important consideration. Embodied energy is the energy used in production and distribution of a product of material. It has been observed that embodied energy of building materials contributes between 5 to 20 percent of the energy used by a building over a 50-year period (Architecture 2003, 2006 -2007; www.architecture2930). Thus, building clients have tremendous influence on choice of materials with low embodied energy is reduce through efficient design technology, embodied energy becomes more relevant in reducing a buildings energy consumption (Olotuah, 2007).

The importance of getting building occupants to help save energy cannot be overestimated. Their practices and activities can make or break energy efficiency efforts. Washington State University, in its energy efficiency facts sheets itemized means of reducing energy use in building by occupants under various Sub-tropics, These precautions include;

(a) Lighting:
- Avoiding the use of incandescent lights (desk lamps). A compact fluorescent lamp will suffice also for halogen floor lamps.
- Turn off lights in unused common space. The effect on common lamp life and energy use when turning the lamp back is neglible.
- Turn off all light at night.
- Turn of lights near windows when day lighting is adequate.
- Many areas are lit more than necessary for their present use. Only use light that are necessary for task being performed.

(b) Equipment
- Turn off your computer monitor when you are away from your desk for more than 15 minutes and compulsorily at the end of the day. Note that monitor account for two-thirds the energy used by computers. Screen savers actually increase energy use.
- Eliminate reserve hot plates, coffeepots and other appliances in your area and switch off all tools, office machines and movable appliances once not in use.
- Less frequently used equipment with remote controls such as television, VCDs, etc., should be unplugged when not in use because they still use some power even when turned off.

2.3Building solution for sustainable feature

Resources are attributes of environment (matter and energy) which man extracts for use. On a broad slate, we can identify two groups of resources;
- INEXHAUSTIBLE
- EXHAUSTIBLE

Inexhaustible are those resources, according to Adeniyi (2000), which are available in such large quantities or are being supplied continuously that from all practical ends they may be regarded as inexhaustible, for example, solar energy. These may however further be subdivided into two , i.e., immutable and misusable. The immutable ones are the ones which there is no way man can affects its quality or characteristics. Examples are atomic energy obtained from solar power, power of waves and precipitation from the atmosphere. The misusable ones, although are available in large quantities, if not properly managed, their quality, serviceability or utility value would be seriously reduced, for example solar energy as a result of air pollution. Water bodies can also be polluted while the landscape scenery can be degraded. This will negate the principle of sustainability.

The exhaustible resources can be sustained perpetually if properly managed because' some of them are renewable, for example, vegetation, etc. while some are not renewable like gas, coal, iron-ore, etc. They renewable resources are otherwise called maintainable because they can be re-used through recyclation, like rubber, plastic etc.; some resources like fossil fuels (coal, oil, gas, gypsum, sand, etc.) cannot be reused. They are non-maintainable. The diagram below illustrates the expression above:

2.4 Alternative Hardwood

Russell, (2008) observed that bamboo can replace hardwood for many purposes.

Bamboo is basically an overgrown form of grass. It varies from dwarf variety of about 300mm high, to gigantic varieties that may grow up to and over 30m. it grows in different climates and locations, from high attitude on mountains to the hot steamy jungle. There are two types of bamboo runners and clumpers. Runners spread quickly and as far as they possibly

can go. Clumpers expandsmore slowly from original plant. Other varieties are combination of both runners and clumpbers. Clumpers grow more in the tropics. There are multiple uses for bamboo, both decorative and structural as construction materials, and also as furniture and kitchen implements.

Bamboo is a very attractive plant to grow even in any garden. There are many types that suite different climates from full sun to full shade. One of the advantages is remarkable to quick growth rate. Since it can be used for so many of the same uses as hardwood, it will end up saving many trees all over the world. For example, a 20m bamboo plant only takes 60 days to replace (Russell, 2008). Therefore, it makes more sense to use bamboo for as much as possible, since it grows faster and has many uses. It is a common plant in many parts of the world. It is a vital part to many country's economies and may even help save the environment as a replacement for slower growing hardwoods. This will reduce vegetables cover depletion that is affecting non-renewable resources.

Teaching Architecture in Nigeria is yet to address the use of bamboo for construction. Its structural details, strength and durability need to be determined and passed on student's architecture.

2.5 Glass Window Efficiency

The use of glass in doors and windows can help lower home heating, cooling and lighting costs. Such windows can combine durability and performances with beauty and value. The use of double glazed glass with outer plane of solar control dark glazing that absorbs solar energy and inner plane of thermal glass which prevents heat loss is a good combination (Folorunso, 2006). Proper use of glass will enhance sustainable energy in buildings. Method of application of glass include;

- **Multiple panes**; two panes of glass with air or gas filled space in between, insulate far better than a single pane of glass. Triple pane windows offer even larger energy efficiency, effect resistance and sound insulation.
- **Low-E Class;** special coatings reflect infrared light, keeping heat inside in cold season and outside in warm season. They also reflect damaging ultraviolet light, which helps protect interior furnishing from fading.
- **Gas fills:** The most energy efficient windows have element like the argon gas between the panels. These odourless, colorless, non-toxic gases insulated higher than regular air.
- **Improved Frame Materials:** Wood composites, vinyl and fiberglass frames reduce heat transfer and help insulate better.
- **Warm Edge Spacers:** A spacer keeps window glass panes the correct distance apart. Today's warm edge spacers reduce heat flow and prevent condensation.

2.6 Some Intelligent Façade Systems

The double skin façade is usually a combination of glass "skins" separated by air passageway. the foremost layer of glass is often insulating. The air space between the layers of glass acts as insulation against temperature extremes, winds, and sound. Sun-shading devices area unittypicallyplaced between the two skins. All componentsis alsoorganizedotherwise into numbers of permutations and combination of each solid and diaphanous membranes. "Using Multiple Glass Skins to Clad Buildings", Werner Lang et al…(2004). Cited 3 basic system types: which are Buffer System, Extract Air System and Twin Face System. The 3 systems vary considerably with relevance ventilation methodology and theirability to cut back overall energy consumption. [2]

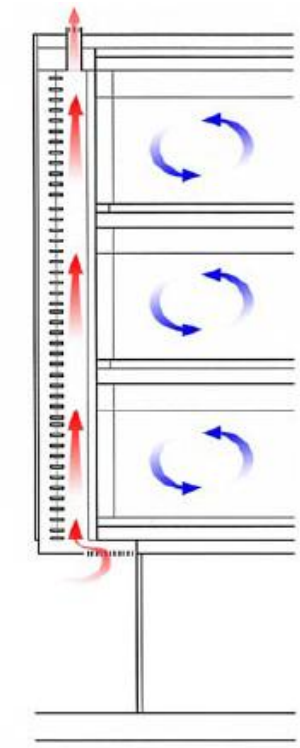

Figure 1:
Buffer System

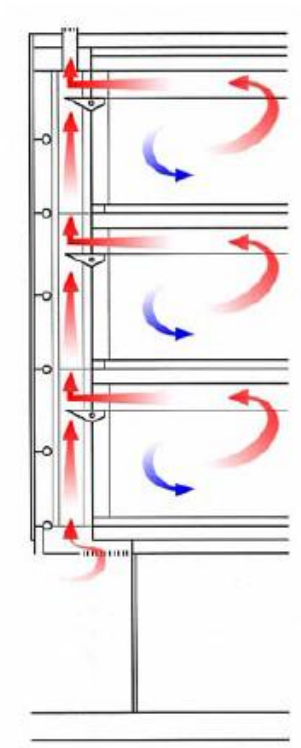

Figure 2:
Extract-Air System

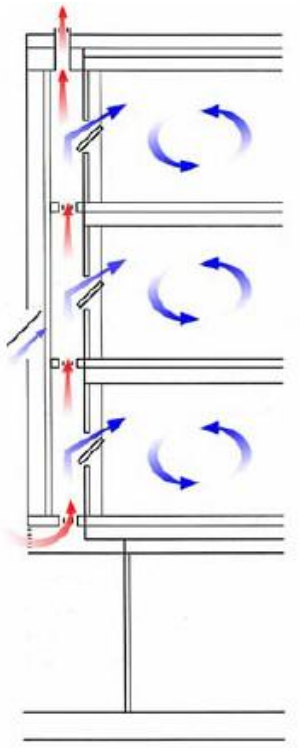

Figure 3:
Twin-Face System

- **Buffer System**:

These façades originate some one hundred years and square measure still used. They predate insulating glass and were fanciedto keep up daylight into buildings whereas increasing insulating and sound properties of the wall system. They use 2 layers of single glazing spaced 250 to 900 millimeter apart, sealed and permittingrecent air into the building through further controlled suggests that – either a separate HVAC system or box kind windows thatgo acrossthe general double skin. Shading devices may beenclosedwithin the cavity. a contemporary example of this kindis that the Occidental Chemical/Hooker Building in Niagara Falls, New York. This building permitsrecent air intake at the bottom of the cavity and exhausts air at the highest.

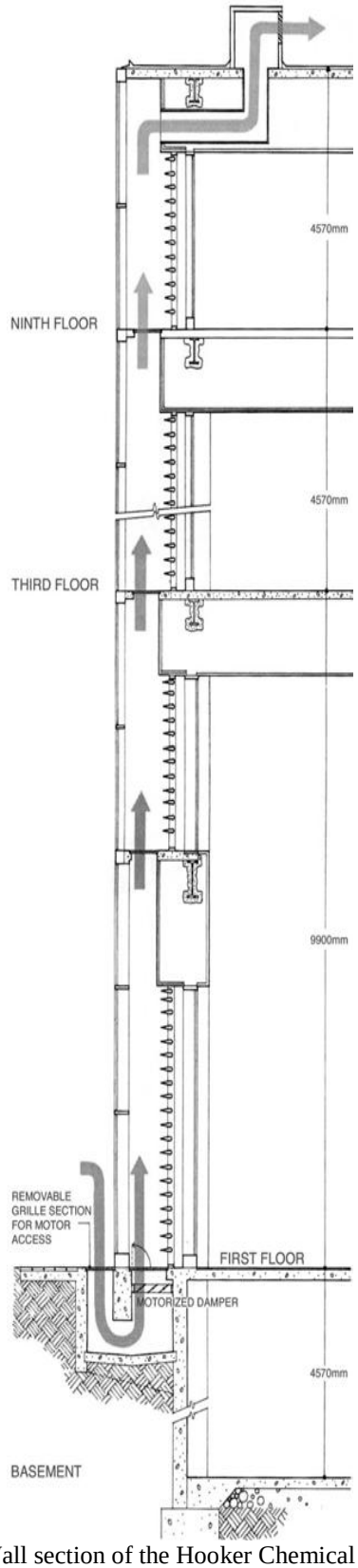

FIG.4.Wall section of the Hooker Chemical Building illustrating a classic buffer façade application that does not allow for fresh air nor mixes the cavity air with the mechanical system.

- **Extract Air System:**

These area unit comprised of a second single layer of glazing placed on interiorof a main façade of double-glazing (thermopane units). The area of air space between the 2 layers of glazing becomes a part of the HVAC system. The heated "used" air between the glazing layers is extracted through the cavity with the utilization of fans and thereby tempers the inner layer of glazing whereas the outer layer of insulating glass minimizes heat-transmission loss. fresh air is equipped by HVAC and precludes natural ventilation.

- **Twin Face System**:

This system consists of a conventional curtain wall or thermal mass wall system withinone glazed building skin. This outer glazing could also be safety or glass which is laminated or insulating glass. Shading devices could also beenclosed. These systems should have an internalarea of a minimum offive hundred(500) to six hundred millimeter(600)to allowimprovement. These systems could also be distinguished from each Buffer and Extract Air systems by their inclusion of openings within the skin to permit for natural ventilation. The single-glazed outer skin is employed primarily for cover of the air cavity contents (shading devices) from weather. With this technique, the internal partof the skin offers the insulating properties to reduce heat loss. The outer glass skin is employed to block/slow the wind in high-rise thingsand permit interior openings and access to contemporary air while not the associated noise or turbulence.

III. DISCUSSION

Energy efficiency is one of the categories of a green building.Energy efficiency focuses on ways that to scale back demand by incorporating energyefficiency options like passive design,natural shading and lighting, high efficiency lighting, buildingcontrols, effective HVAC management and conjointly includes activity renewable energy by supplying technologies like solar photovoltaic panels, electric heaters among othersThis section attempt to solve the questions regarding to the needsfor some relevant featuresfor build environmental needs in Nigeria and around the world. An attempt to consider some technology feature.

- What is the energy efficiency of a building?

The energy efficiency of a building is the extent to which the energy consumption per square meters of floor area of the building measures up to established energy consumption benchmarks for that particular type of building under defined climatic conditions. Building energy consumption benchmarks are representative values for common building types against which a building's actual performance can be compared.

- Why is energy efficiency in buildings important?

The main benefit from measures to improve energy efficiency buildings is lower energy costs but there are usually other benefits to be considered too. Energy efficiency measures are meant to reduce the amount of energy consumed while maintaining or improving the quality of services provided in the building. Among the benefits likely to arise from energy efficiency investments in buildings are:

- Reducing energy use for space heating and/or cooling and water heating;
- Reduced electricity use for lighting, office machinery and domestic typeappliances;
- Lower maintenance requirements;
- Improved comfort;
- Enhanced property value.

Building insulation feature is one of the important techniqueto be considered.

Techniques such as Double Skin façade systems, Roof and insulation on Walls that hold heat and air ultimately reducing energy costs for heating and cooling.

- Where to install insulation

The biggest loss of heat is through your ceiling and roofs (up to 45%), thus good ceiling and roof insulation is the favorite priority. Install insulation under the roofing material to reduce radiant heat gain. Install insulation within the ceiling to reduce heat gain and loss.

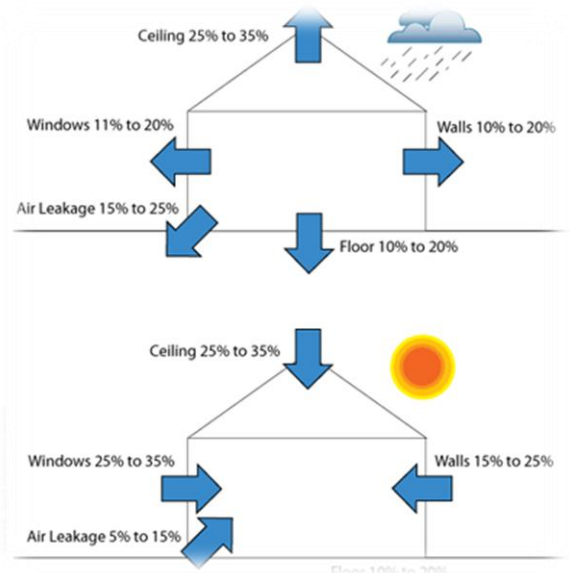

FIG.5. HOW INSULATION WORKS

IV. Conclusion and Recommendation

A sustainable society restores, preserves and enhance nature and culture for benefit of all life present and future; a diverse and healthy environment is intrinsically valuable and essential to health society (Adedeji, 2007). Technology is dynamic, while human needs are ever changing due to socio-economic factors. It is therefore, pertinent for all players in the field of architecture to put heads together in order to fine-tune professionalism and architecture school's curriculum in order to meets with present realities. Energy supply in Nigeria is at lowest ebb in the past two decades. This has imparted negatively on all facet of the country's economy. Architects should simply get involve in finding the way out of retrogressive tendency. Research should be geared towards finding more energy conservation materials from construction to reduce the need for cooling the interiors especially during dry season. The use of Sand Crete blocks and bricks for wall alone which emits heat in to the interior after sunset due to intense solar radiation need to be researched into with a view to discover bettermaterials that will reduce the amount of energy needed to cool the building.

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