# THE ROLES OF ARCHITECTURAL EDUCATION IN ACHIEVING SUSTAINABLE ENERGY BUILDINGS IN NIGERIA.

BY

**OGUNTIMEHIN, Abiodun Sunday** and OLUBODUN, Matemilegbe Elijah

DEPARTMENT OF ARCHITECTURAL TECHNOLOGY,

THE FEDERAL POLYTECHNIC, ILARO.

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**ABSTRACT**

*The field of sustainability is gaining prominence in higher education, while teaching sustainability includes information from many academic fields, it should also include the expertise of the architect. Also energy has become a critical issue in national and global economic development. It's 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 economies 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 available 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 and that are being environmentally compatible.*

**Keywords**: Sustainable; Energy, Building; Materials; Architectural Education

**INTRODUCTION**

Sustainable building development entails that building resources are optimally used by present generation without jeopardizing the future of the unborn. While man extracts matter and energy from the environment, he also gives something in return. The natural environment works like a living organism, just like the built environment - the people react with it and it reacts with people. The Urban environments are the mirror with which we reflect our beings; to look at our cities is to see into our future (Oguntimehin & Bamidele, 2015). Simonds (1999) admits that when we recreate the environment, the environment recreates us.

Thus, his impact on the environment in any area depends on the magnitude, rate and manner of his extraction of resources and that of the feedback. It entails using resources to achieve greatest good for the largest number for the largest possible time. The era of ample and cheap fossil is fast ending, making energy to become a critical factor in national and global economic development. (Adedeji, 2007). The sumptuous use of energy to create interior condition and lighting to create comfort condition and lightings that largely ignore the natural environment is no longer fashionable. The architecture of today 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 materials and technology. (Adedeji & Folorunso, 2009).

Many professional architects are knowledgeable in aspects of the built environment critical to sustainability. In addition, the art of the architect, that is, the design process is a model for resolving problems by integration instead of dissection, appropriate to complex issues such as many found in sustainability. Sustainability is a crucial issue for our time and architecture has an important role to play in sustainable development. Buildings are responsible for approximately 40% of the total world annual energy consumption. (Acheampong, 1998). In addition, over the past decade, several new approaches have emerged for the incorporation of sustainability and renewable energy into architectural education. One way of reducing building energy consumption is to educate architects in the design of buildings which are powered by renewable forms of energy for heating, lighting, cooling and ventilation. A comparison of sustainable architectural education in economically developed countries with that in developing ones provides some insights about how to modernize the architectural curriculum to facilitate the process of sustainable development. (Isidore, Olotuah, & Fagbenle, 20014)

**Design and Materials Strategies**

Low-energy building design is not just the result of applying one or more isolated technologies. Rather, it is an integrated whole-building process that requires advocacy and action on the part of the design team throughout the entire project development process. (Elusakin, Adije, & Diji, 2014). The whole-building approach is worth the time and effort, as it can save 30% or more in energy costs over a conventional building designed in accordance with Federal Standard. (Nwafor, 2006) Moreover, low-energy design does not necessarily have to result in increased construction costs. Indeed, one of the key approaches to low- energy design is to invest in the building's form and enclosure (e.g., windows, walls) so that the heating, cooling, and lighting loads are reduced, and in turn, smaller, less costly heating, ventilating, and air conditioning systems are needed.

Strategies for achieving energy efficiency in building could be through design, materials and application of technology initiatives that are responsive to climate conditions. In 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 openings for ventilation and circular house form as solution to the enormous solar heat gained. Softly rounded curvilinear surfaces and rough textures of earthen walls causes 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 afternoons and warn interior during the nights. This is mud, which has very high heat storage capacity, takes considerable time to heat up and long time to cool down. It absorbs heat slowly in the afternoons and dissipates it slowly at night. Mechanical cooling equipment can thus be completely avoided in buildings. (Akpan & Isihaik, 2013)

In the temperate regions appropriate design, materials and technology could be used to reduce the need for fossil-fuel energy. There are a number of design techniques that are of reduced cost or lower-cost. These strategies can dramatically reduce the home's need for fossil fuel energy. Conceptually, in temperate climates of 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 orientation of the building should vary with its micro climatic factors in order to gain maximum benefit from natural cooling and heating techniques. (Ogunsote and Ogunsote, 2002)

**Material Selection and Embodied Energy**

The type of materials used in construction of a building will to a large extent determine the degree of comfort or discomforts of the building (Folorunso, 2005). Careful selection of environmentally sustainable building materials is the easiest way for architects to begin incorporating sustainable design principles in buildings. Traditionally, price has been the foremost consideration when comparing similar materials or materials designated for the same function. However, the "off-the-shelf" price of a building component represents only the manufacturing and transportation costs, not social or environmental costs. (Jong-Jing, 1998).

The embodied energy of a material refers to the total energy required to produce that material, including the collection of raw materials. This includes the energy of the fuel used to power the harvesting or mining equipment, the processing equipment, and the transportation devices that move raw material to a processing facility. This energy typically comes from the burning of fossil fuels, which are a limited, non-renewable resource. The combustion of fossil fuels also has severe environmental consequences, from localized smog to acid rain. The greater a material's embodied energy, the greater the amount of energy required to produce it, implying more severe ecological consequences. For example, the processing of wood (harvested in a sustainable fashion) involves far less energy and releases less pollution than the processing of iron, which must be extracted from mined ores.

**Natural Materials**

Natural materials are generally lower in embodied energy and toxicity than man-made materials. They require less processing and are less damaging to the environment. Many, like wood, are theoretically renewable. When natural materials are incorporated into building products, the products become more sustainable (Lowton, 1997)

**Non-Toxic or Less-Toxic Materials**

Judith, 2000 claims that Non- or less-toxic materials are less hazardous to construction workers and a building's occupants. Many materials adversely affect indoor air quality and expose occupants to health hazards. Some building materials, such as adhesives, emit dangerous fumes for only a short time during and after installation; others can contribute to air quality problems throughout a building's life.

**Energy Efficiency**

Energy efficiency is an important feature in making a building material environmentally sustainable. The ultimate goal in using energy-efficient materials is to reduce the amount of generated energy that must be brought to a building site. The long-term energy costs of operating a building are heavily dependent on the materials used in its construction (Charles, 2004). Depending on type, the energy-efficiency of building materials can be measured using factors such as R-value, shading coefficient, luminous efficiency, or fuel efficiency. Preferred materials slow the transfer of heat through a building's skin, reducing the need for heating or cooling. Quantitative measurements of a building material's efficiency are available to help in the comparison of building materials and determining appropriateness for certain installations.

R-Value: Building envelopes are generally rated by their insulating value, known as the R-value. Materials with higher R-values are better insulators; materials with lower R-values must be used in thicker layers to achieve the same insulation value. R-values can be measured for individual materials (e.g., insulation, siding, wood paneling, brick) or calculated for composite structural elements (e.g., roofing, walls, floors, windows). Many types of insulation materials are available, from organic cellulose made from recycled paper to petrochemical-derived foams. (Matteo, 2003)

**Renewable Energy Systems**

Building sites are surrounded by natural energy in the forms of wind, solar radiation, and geothermal heat. Renewable energy systems can be used to supplement or eliminate traditional heating, cooling, and electrical systems through the utilization of this natural energy. Components that encourage day lighting, passive and active solar heating, and on-site power generation are included in this category. Solar power can be utilized in many forms, both for heating and production of electricity. In many parts of the country, wind power is a feasible way to generate electricity and pump water. Active solar or geo-thermal heat requires outside electricity for pumps but still saves energy in comparison to the operation costs of traditional mechanical systems. (Reed and Gordon, 2000)

According to Bauer et. al., Sustainable Buildings should:

- Be adapted specifically to site climate and evolve as conditions change.
- Be esthetically pleasing
- Harvest all of their own water and energy needs on site.
- Improve the health and diversity of the local ecosystem rather than degrade it.
- It should comprise energy efficient integrated systems that maximize efficiency and comfort
- Operate pollution free and generate no waste that aren't useful for some other process in the building or immediate environment.
- Promote the health and well-being of all inhabitants, as a healthy ecosystem does.

**Guides towards Achieving Sustainability in Architectural Designs**

- **Window Positioning:** A building cannot be sustainable unless its interior design is not in tandem with it. Solar and Wind energy should be made use of and the orientation and placement of a site should be looked into. Positioning of windows should be such that they allow cross ventilation, thus creating climate sensitive design. Glass can be used as facade cladding with opaque insulation thus helping in keeping the building cool. Special venetian blinds further cool the rooms.
- **Day lighting**: This is an important factor that has considerable importance in case of any design. Day lighting reduces the need for artificial lighting thus saving energy.
- **Choice of Furniture**: For furniture, instead of hardwoods, renewable materials like rubber wood, bamboo and cane can be used.

- **Landscape**: Landscaping should be done on roofs and around the building to minimize excess solar gain.
- **Technology**: Innovative construction techniques for roofing such as domes, arches and precast brick panels should be used as they reduce energy consumption of a building. Non-mechanical systems for cooling and heating should be preferred, introducing air-conditioning only when absolutely necessary. Sustainable design is the thoughtful integration of architecture with electrical, mechanical, and structural engineering. In addition to concern for the traditionalism, aesthetics, massing, proportion, scale, texture, shadow and light, the design team needs to be concerned with long term costs: environmental, economic and human. All in all, a sustainable design is more a practical philosophy of the building than perspective building style.
- **Shading Coefficient**: Although day lighting is the cheapest and most pleasant form of illumination, the accompanying heat gain from direct solar radiation is not always welcome, particularly in hot climates. The shading coefficient (SC) is a ratio of the solar heat gain of a building's particular fenestration to that of a standard sheet of double-strength glass of the same area. This allows a comparison of the sun-blocking effectiveness of various glass types, shading devices, and glazing patterns. Shading devices can be designed to block solar heat gain at certain times of the day or year: overhangs are often used to block high summer sun but admit direct light during the winter. Certain types of glass or applied films allow selective transmission of the visible radiation (light) while preventing or reducing the transmission of infrared radiation (heat).
- **System Efficiency:** Electrical and mechanical systems are responsible for more than 50% of a building's annual energy costs. Heating, ventilation, and air-conditioning (HVAC) systems should be selected for the greatest efficiency at the most commonly experienced temperatures. A system that offers peak efficiency at an outdoor temperature experienced by the building's

climate only 5% of the time will not necessarily be the best choice. Regular maintenance programs are also necessary to keep equipment operating at peak efficiency.

**Water Treatment/Conservation**

Products with the water treatment/conservation feature either increase the quality of water or reduce the amount of water used on a site. Generally, this involves reducing the amount of water that must be treated by municipal septic systems, with the accompanying chemical and energy costs. This can be accomplished in two ways: by physically restricting the amount of water that can pass through a fixture (showerhead, faucet, and toilet) or by recycling water that has already entered the site. For instance, gray water from cooking or hand-washing may be channeled to flush toilets; captured rain water may be used for irrigation. Water Conservation issues address efficient use of water as well as an overall reduction in the volume consumed. Water-saving showerheads and toilets are now widely used in residences as well as commercial buildings.

The advantages of composting toilets are that no waste enters the already overburdened waste stream, and the resulting compost can be used as fertilizer. The potential to separate the wastewater stream into “gray water” (dirty from washing or cooking but not containing human or animal waste) and “black water” (sewage containing biological waste or factory effluent) can be incorporated into plumbing and fixture design. Restrooms in Japan commonly direct water from the sink drain to the toilet tank, where it is used to flush toilets. The use of indigenous plants that are drought-tolerant reduces the need for irrigation, as important a consideration for the homeowner in Detroit as in Phoenix. Rainwater collected from roofs or paved parking lots can beused for flushing toilets and landscape irrigation. The building itself can be designed to act as a collector of rainwater, to be stored in a cistern for later use. For health reasons, current building codes prohibit the use of this gathered water for human consumption, but it is possible that future water purification devices will make on-site water safe to drink —at a lower cost than current municipal water treatment.

**Roles of Architect in Energy Sustainability**

The building Energy Corporation of the United States in 2013, observes that buildings should be designed, built, renovated or re-used to be environmentally responsible and economically beneficial. It should provide healthy living and work spaces. Sustainable energy, a key 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 more cost effectively. A good building design and envelop protects the interior from external elements such as moisture and temperature, and prevents 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 into building designs and the use of photovoltaic and thermal solar energy systems minimize dependence on fossil fuel energy sources.

**Conclusion and Recommendation**

According to Vitruvius, a building or design is said to be architecturally acceptable only if that building is Functional, Aesthetically pleasing and structurally stable. A sustainable society restores preservers and enhances nature and culture for the benefit of all life present and future; a diverse and healthy environment is intrinsically valuable and essential to healthy society (Adedeji, 2007). Technology is dynamic, while human needs are ever changing and increasing due to socio-economic factors. It is therefore, pertinent for all players in the field of Architecture to put minds together in order to upgrade the curriculum so as to meet the present realities. From the foregoing, this paper concludes that there is need to inculcate the use of natural and energy friendly materials in our buildings to ensure adequate sustainability in the environment.

It therefore recommends that adequate research; human, financial and time resources must be devoted to sustainable architectural education. Architectural educators and professionals should promote sustainable architecture through direct experiential learning, using appropriate methodologies. Tools and techniques must continually evolve and disseminate the knowledge base of sustainability through exemplary research and architectural practice.

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