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Benefits of building and Renewable Energy towards Sustainable Development

Idowu Faruq Ayobami[1], SalawuAbdulfatai Oyebode[2], Gimba Shuaibu Danladi[3]
[1]*Department of Quantity Surveying, Ahmadu Bello University, Zaria, Kaduna State*
[2]*Department of Estate Management, College of Built Environment, Hussaini Adamu Federal Polytechnic, Kazaure. Jigawa State.*
[3]*Department of Estate Management, College of Built Environment, Hussaini Adamu Federal Polytechnic, Kazaure. Jigawa State.*

Abstract: Even though domestic energy can be from either renewable or non-renewable source, the former is preferred because of its role in reducing both the operational energy intensity and carbon footprint. Given the positive role renewable energy plays in the mix. This paperexamined theavailable renewable energy,provides an overview of renewable energy resources and available technologies used successfully to offset building electrical and thermal energy loads.The study found that renewable energy use in building is very low. In contrast, there was high dependence of the building occupants on non-renewable direct fuel combustion through the use of fossil fuel-driven privately-owned electricity generators for electricity supply. The chosen research approach was quantitative; including a comprehensive review of extensive relevant literature.This results revealed that buildings are responsible for about 45% of global carbon dioxide emissions over the entire life cycle and incorporating energy efficiency reduced the building sector's contribution toward global energy consumption through reduction of energy use in new and existing buildings.The Researcher therefore recommend an increase in renewable energy use both innew and in an existing buildings.

Keywords: Renewable Energy, Retrofit Building, Sustainability Development
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I. INTRODUCTION

Buildings play vital roles in global energy consumption and carbon dioxide emissions. Carbon dioxide emissions from buildings are due largely to the high carbon content of delivered energy for building operations (Vossenaar & Jha, 2010). One ofsuch low-carbon energy source is renewable energy which includes solar energy, wind energy, geothermal energy, ocean energy, bio-energy and hydropower (Ezema,Olotuah, and Fagbenle, 2016). Renewable energy is a sustainable form of energy as it is from naturally occurring, non-depleting resources. Benefits such as decreased building operational energy costs have prompted growing interest among policy makers, the technical community, and the general public in addressing building energy issues and investigating solutions for decreasing building energy consumption. Sheila and Alice (2011) suggested that there is an opportunity for reducing the building sector's contribution toward global energy consumption through reduction of energy use in buildings. Reducing building energy consumption consists of two synergistic approaches:

1. To reduce the need for energy through implementation of energy efficiency measures
2. To offset the remaining building energy needs through use of renewable energy systems

It is important to note that building energy efficiency measures should be considered first, as the cost to invest in efficiency measures is approximately half the cost of installing renewable energy generating capacity equal to what the efficiency measures offset (IEA, 2006). It is advised that all energy efficiency opportunities are explored and as many are implemented as is feasible before or in conjunction with renewable energy projects for buildings.

II. PROBLEM STATEMENT

There are many synergies between buildings and energy-efficient and renewable energy technologies. It is evident that due to the fragmented nature of the construction industry there is needs to be somebody driving energy efficiency for it to be considered (Eastman,Teicholz, Sacksand Liston, 2011).
Sorrell (2003) suggests that capital constraints are a primary reason for the lack of energy efficient measures being taken. In spite of the obvious advantages of renewable energy, its uptake in various contexts especially in

developing countries has not been seamless as it is beset by a myriad of barriers. In general, the barriers to renewable energy technology (RET) deployment include financial barriers (Moula, Hamdy, Fang,& Lahdelma 2013; Nasirov, Silva & Agostini, 2015), technological or grid connection barriers (Nasirov et al., 2015), regulatory or administrative barrier (Moula et al., 2013), as well as social acceptability barriers (Sriwannawit & Laestadius, 2013; Moula et al., 2013).

As a consequence, there is low usage of renewable energy in building and an increase in both operational energy intensity and carbon footprint, and also the persistent high dependence of the building occupants on non-renewable energy combustion.

III. RESEARCH METHODOLOGY

The chosen research approach is quantitative in nature, including a comprehensive review of relevant literature whichwas undertaken to assess the frequent use of renewable energy by building occupantsand develop an understanding of previous work in the field of building and renewable energy in construction industry.

Various means was used to gather information with regards to benefit of renewable energy in buildingssuch as textbooks, institutional and statutory publications, periodicals and trade/academic journals, seminar and electronic journal databases and conference proceedings that focus on technical opportunities, and means for incorporating renewable energy technologies.

The finding was further strengthened by interviews with experienced personnel to obtain information from a spectrum of Registered and practicing Estate Surveyors, Quantity Surveyors and Builders and perspectives regarding the aspects in the objectives of the research.

IV. BUILDING and RENEWABLE ENERGY

Building and renewable energy (BRE) provides an opportunity to reduce our carbon footprint and bring energy directly and efficiently to end users. This Part defines the term BRE and explains how it can help reduce the negative impact of buildings.

A. *Building;*is a relatively permanent enclosed construction over a plot of land, having a roof and usually windows and often more than one level, used for any of a wide variety of activities, as living, entertaining, or manufacturing (Austin, 2015).

B. *Renewable energy*; Any energy resource that is naturally regenerated over a short time scale and derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy). Renewable energy does not include energy resources derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources(Austin, 2015).

Building renewable energy include solar, wind, geothermal, and fuel cell technologies incorporatedinto inhabited structures and used bythose structures' occupants. (Sara, 2012). Renewable energy has an important role to play in meeting the future energy needs in both rural and urban areas. Sorrell (2003) states that; 'the energy efficiency of buildings is critical to a sustainable future. It is highlighted that new construction can take advantage of energy efficient technology if the right choices are made on building form, fabric, orientation and building services.

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 .These resources are replenish fast enough as they are used. Natural solar energy enables both poor and rich people to have access to light energy that can be used for various activities.

RENEWABLEENERGY UTILIZATION AND CONSERVATION IN NIGERIA

The method in which buildings are designed and built in Nigeria compliments conservation especially in the rural area; this is as a result of the limited resources. In the rural area the shapes, forms and functions are still very traditional and materials used are predominantly clay and mud. At the late end of colonization, traditional buildings were not preserved and subtly destroyed, especially in the metropolis. The discovery of oil and prosperity that comes with it saw a large influx of ideas and styles in building from international scenes to the postmodern style as well as high-tech. Most of these buildings did not consider the standard and requirement for building them in the various localities and a great deal of energy was required in buildings to provide; cooling, lighting and other gadget requirements. The energy sources, after all is exhaustible and coupled with the limitation in technological base, policy are needed to enhance the conservation of the energy source (Thomas 1980).

RENEWABLE ENERGY RESOURCES AND TECHNOLOGIES

Nigeria has abundant renewable energy sources which have been identified by sources assessment studies to include Solar Energy, Wind Energy, Biomass and Geothermal(Shaaban &Petinrin, 2014).Renewable energy resources commonly used for building applications include solar, wind, geothermaland biomass.

Before selecting an appropriate renewable energy technology to apply to building retrofit project, it is important to first consider a number of factors. Examples of these factors include:

• Available renewable energy resource at or near the building site
• Available area for siting of the renewable energy technology
• Cost of energy purchased from the electrical or thermal energy provider for the building
• Local regulations affecting renewable energy systems
• Characteristics of the energy profiles to be offset by the renewable energy installation.

Examples of renewable energy technologies that can be incorporated with building energy systems include:

➢ Solar thermal, including solar hot water (domestic water heating and space heating)
➢ Solar electric, or photovoltaic (PV), systems and
➢ Solar ventilation air preheating
➢ Geothermal heat pump
➢ Wind turbines
➢ Biomass systems.

More information on each technology is provided in the following sections

SOLAR THERMAL

Solar water heating can be a cost-competitive way to generate hot water or air and eliminate both the cost of electricity or fossil fuel as well as the associated environmental impacts.

Solar Hot Water Systems;Solar hot water systems use a collector to absorb and transfer heat from the sun to water;sunshine strikes some surface, usually black for maximum solar absorption, which in turn heats air or water. A protective layer of glazing helps to retain heat captured, which is stored in a tank until needed. These systems are categorized by the temperature at which heat is most efficiently delivered and the collector type that is best suited for that delivered temperature, including low-temperature (unglazed collectors), mid-temperature (flat-plate collectors), and high-temperature (evacuated tube collectors).


Figure i. Solar electric, or photovoltaic (PV), systems;

Sources: Photos by (from left) Albert Nunez,, NREL/PIX 10651; Todd Spink, NREL/PIX 10050; Alan Ford, NREL/PIX 09501

Perhaps, it is among the best options for Nigeria especially being in the tropics where there is so much sunshine to convert and in view of its apparent limitless potentials. According to (Alsema and Nieulaar, 2000) **photovoltaic (PV)** energy conversion is widely considered one of the promising renewable energy technologies which has the potential to contribute significantly to a sustainable energy supply and which may help to mitigate greenhouse emissions(Jackson and Oliver, 2000; Johansson *et al.*, 2004).PVcells employ semiconductor material to generate a flow of electricity when struck by sunlight. PV arrays convert sunlight to electricity.

The panel systemsare made up of modules assembled into arrays that can be mounted on or near a building or other structure (Figure ii). A power inverter converts the direct current (DC) generated by the system into grid-quality alternating current (AC) electricity.

Figure ii (Modules assembled into array) Source; http;// sourceenergypakistan.blogspot.com/

Many solar panels combined together to create one system is called a solar array. For large electric utility or industrial applications, hundreds of solar arrays are interconnected to form a large utility-scale PV system (NREL 2009). These systems are generally fixed in a single position but can be mounted on structures that tilt toward the sun on a seasonal basis or on structures that roll East to West over the course of a day (NREL 2011). The space required for solar PV is significant. Solar cells are typically mounted in modular panels, which are installed in arrays that can be ground, pole, or roof mounted.

These cells convert sunlight directly into electricity, and the systems may be tied directly into the utility grid. When the photovoltaic system produces more electricity than the house is using, that electricity flows back into the utility's wires, and it is purchased by the utility at a competitiverate. When the house requires more electricity than the photo-voltaic can provide, it is purchased from the utility in conventional fashion.

SOLAR VENTILATION PREHEATING SYSTEMS

Solar ventilation preheating systems heat ventilation air for applications needing high volumes of ventilation air. In principle, the sun warms the collector surface, where heat is then conducted from the surface to a thermal boundary layer of air. Fans then draw the boundary layer though holes in the collector before the heat can escape by convection (Figure 3).

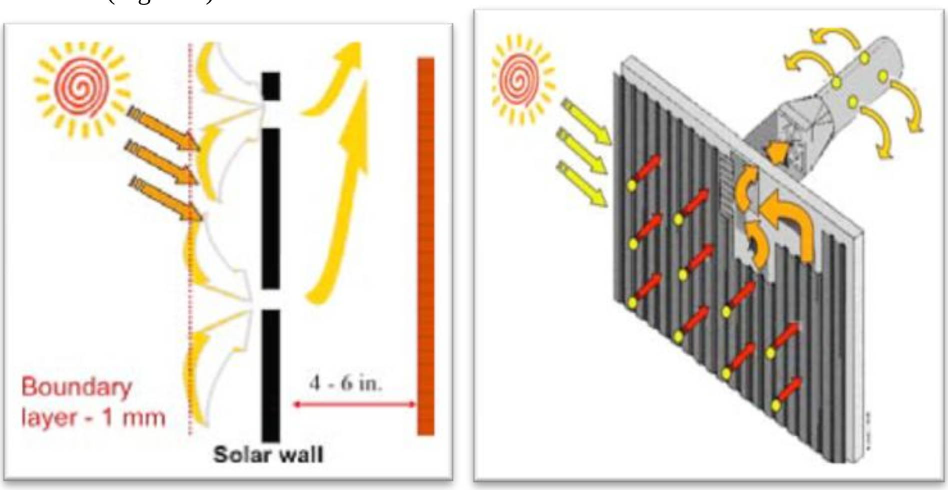


Figure iii Solar ventilation preheating collector operation. (Source: National Renewable Energy Laboratory)

Solar ventilation preheating collectors can be added to a building in a retrofit project. Factors to consider when determining whether solar ventilation preheating is a good option for a facility include: relatively high utility rates for heating, a relatively long heating season, and the building’s southfacing wall has enough surface area to mount the collector.

GEOTHERMAL

Geothermal technologies use the heat from the center of the earth. Geothermal resources include the heat retained in shallow ground, hot water and rock found a few miles beneath the earth's surface, and extremely high-temperature molten rock called *magma* located deep in the earth. Almost everywhere, shallow ground, or the upper 3 meters of the earth's surface, maintains a nearly constant temperature of 10°–16°C. Using geothermal heat pumps, this heat can be tapped to provide heating and cooling for homes and buildings. Deeper and warmer geothermal reservoirs can be tapped directly for heat or through advanced technologies for bothheat and electricity generation (DOE 2011a). Building applications for geothermal technologies include geothermal heat pumps and direct use of the geothermal resource. However, because geothermal heat pumps are the most common geothermal energy technology used in buildings, this is the only geothermal technology discussed further in this paper.

Geothermal heat pumps use the constant temperature of the earth as an exchange medium for heat. Although, Nigeria experience seasonal temperature extremes from scorching heat in the summer to 8^{o}C cold in the winter the ground a meter or so below the surface remains at a relatively constant temperature. Geothermal heat pumps are able to heat, cool, and, if so equipped, supply homes and buildings with hot water. A geothermal heat pump system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger a system of pipes buried in shallow ground. In the winter, the heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water.

There are four types of geothermal heat pump systems. Three of these horizontal, vertical, and pond/lake are closed-loop systems. The fourth type of system is open-loop. Which system is best for a particular site depends on the climate, soil conditions, available land, and local installation costs. All of these approaches can be used for residential and commercial building applications (DOE 2011b). Installing geothermal heat pumps in building retrofit projects impose an added level of complexity of locating the loops on site and tying the geothermal heat pump system to the existing building heating, ventilating, and air-conditioning system. The above-ground heat pump is relatively inexpensive; with underground installation of ground loops (piping) accounting for most of the system’s cost. Increasing the capacity of the piping loops can scale this technology for larger building or locations where space heating and cooling as well as water heating, may be needed for most of the year.

WIND

Wind energy is created by uneven solar heating of the Earth’s surface. This wind flow, or motion energy, can be harnessed by modern wind turbines to generate electricity. Wind turbines use rotating propeller-like blades to harness the energy in the wind and drive a turbine that generates electricity. Before installing a wind turbine, it must be established that the wind resource in a specific location is adequate. Wind resource is classified according to its potential to produce electricity over an annual basis (Table 1) but wind resource at a micro level can vary significantly. Therefore, it is important to evaluate the specific area of interest before deciding to invest in wind systems.

Table 1; Wind Resource Classifications.

Wind power class	Resources Potential	Wind Speed at 50m (m/s)
1	Poor	<5.6
2	Marginal	5.6–6.4
3	Fair	6.5–7.0
4	Good	7.0–7.5
5	Excellent	7.5–8.0
6	Outstanding	8.0–8.8
7	Superb	>8.8

Most wind turbines are designed for an operating life of up to 20 years and require little maintenance during this period. Wind turbines require land area, so on-site wind power generation usually occurs for projects having space for installing the turbines (Figure iv) Roof-mounted wind systems are beginning to be used in some building projects. However, building designers should carefully consider issues such as maintaining the building’s structural integrity, noise, and the added cost before determining if building-mounted systems are appropriate for a specific project.

Figure iv

The City of Medford, Massachusetts, USA owns a Northern Power Systems Northwind 100 wind turbine sited at McGlynn Elementary and Middle School. ***Source: Photo from Northern Power Systems, NREL/PIX 16729***

BIOENERGY

There are many types of biomass organic matter such as plants, residue from agriculture and forestry, and the organic component of municipal and industrial wastes that can be used to produce fuels, chemicals, and power. Wood has been used to provide heat for thousands of years. This flexibility in materials has resulted in increased use of biomass technologies (DOE 2011d). Biomass technologies break down organic matter to release stored energy from the sun. The process used depends on the type of biomass and its intended end use. For example, biofuels and bio-power can be used to provide heat or electricity for buildings. Biofuels are liquid or gaseous fuels produced from biomass. Most biofuels are used for transportation, but some are used as fuels to produce electricity (DOE 2011e). Biofuels include ethanol and biodiesel. Bio-power is the production of electricity or heat from biomass resources. Bio-power technologies include direct combustion, co-firing, and anaerobic digestion (DOE 2011f).

Data Analysis Techniques

The administration of the questionnaire began in February 2017 and completed in March, 2017. A period of four weeks was allowed for the administration of the Questionnaire; however, all the completed questionnaires were retrieved by the sixth week. A total of 55 questionnaires were administered to the construction firms, which targeted at contractors. A total of 41was returned form the respondents representing 75%.and further strengthened by interviews with experienced personnel to obtain information from a spectrum of Registered and practicing Estate Surveyors, Quantity Surveyors and Builders and perspectives regarding the aspects in the objectives of the research.

The questionnaire was based on benefit and frequent hierarchy use of renewable energy technologies incorporated in building energy systems include:

- It employed the four-point type Likert ordinal scale to measure level of usage by responding firms from scale: **(Note: 1= Never used; 2 = Not Often used; 3 = Often used; 4 = Very often used)**

The total administered questionnaires and the return rate are shown below;

TABLE 2. ***Detail of Questionnaires Administered and Returned***

	No Sent	*No Returned*	***Response rate (%)***
Professionals	***55***	***41***	***74***

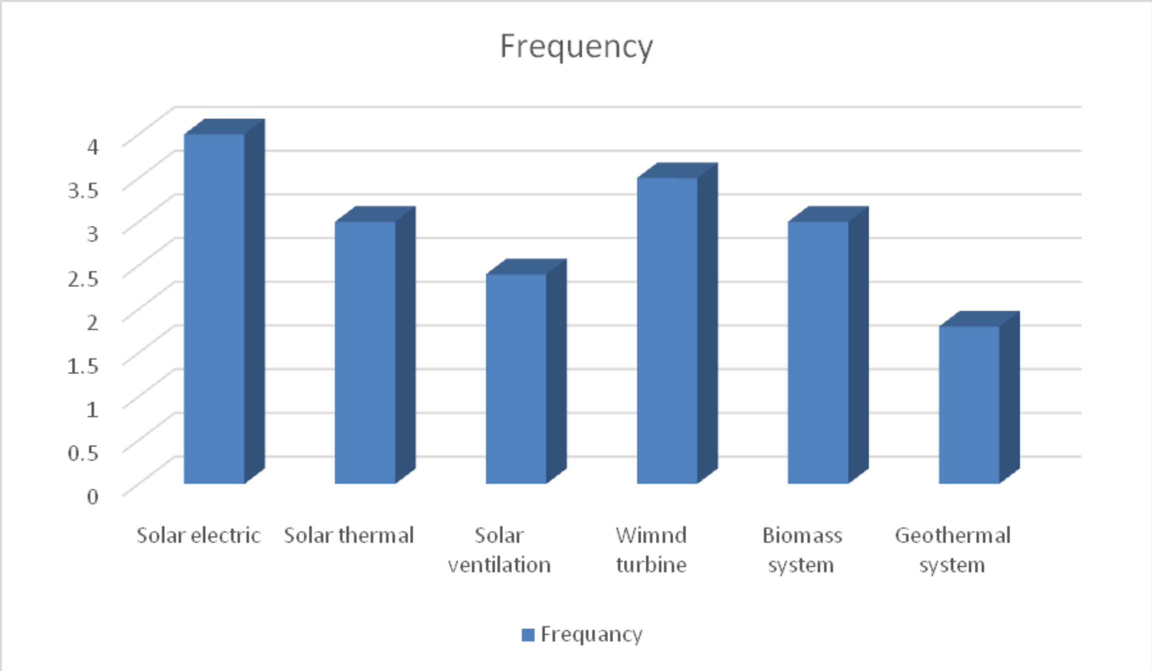
Source: Questionnaire Survey; February-March, 2017.

Typically, there are two general types of statistic that are used to describe data:

Measures of central tendency: these are ways of describing the central position of a frequency distribution for a group of data. For the purpose of this research, we described this central position using the mean statistics. The mean is used to compute the standard deviation. The standard deviation is used to compare the extent of variation of two or more factors. The computer software that is used for analysis of data is the SPSS (Statistical Packages for Social Science).

Frequent use of renewable energy from Respondent

From the responses obtained, the frequent/commonuse of renewable energy technologies incorporated in building energy systems;



V. CONCLUSION

Given a large contribution to global emissions, buildings are ripe for retrofits that result in reduced energy consumption and associated emissions. Conserving and rehabilitating buildings operates more efficiently and cleanly can reduce energy use, energy cost, and greenhouse gas emissions. Green design can work its wonders on any scale, this is by adopting organic buildings; this is a building that would have a kind of holistic approach in its pattern, that would conserve energy and nature as a whole and consider cost as well.

VI. RECOMMENDATION

The enormous advantages of renewable energy can be deployed during the procurement process leading to bridging the housing deficit. In thisrespect, the use and increase in use of renewable energy building is recommended.. For this to be achieved there is a need to create awareness on the shift to green building both in our educational curriculum and in the field of our built environment and much concern and effort given to formulating the policies, strategies to implement programs to develop green building and its related technology

Further research

Further research on the ways of encouraging renewable energy use in the study area is required. Given the high initial cost of renewable energy technology as reported in previous studies, research should focus on long term economic benefits to the user as well as incentives for the adoption for RET in new building as well as for the installation of RET as retrofits to buildings should be encouraged.

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