

## THE BENEFITS OF RENEWABLE ENERGY SOURCES IN THE BUILT ENVIRONMENT

**L.A.T Lawal**

Department of Architecture,  
Federal University of University, Minna, Nigeria.  
[latiadelawal@yahoo.com](mailto:latiadelawal@yahoo.com)

### ABSTRACT

*The importance of energy in the built environment cannot be overemphasized. In Nigeria, energy is being supplied to every home and built up areas through fossil fuels and hydro-systems. The supplies of energy through these sources are not only unreliable but also have inherent dangers associated with their use with attendant pollution of the environment. Despite this shortcoming, most countries of the world ironically, still continue to rely on these sources for their energy supply. This paper seeks to explore other renewable sources of energy that can be used in the built environment. It examines solar energy as a veritable alternative for Nigeria because of the abundance supply of sunlight in the country which has not been optimally utilised. It presents the experiences of countries in Africa and North America who have adopted the use of solar energy in their various communities. The paper gives suggestions toward ensuring adequate and affordable electricity in the built environment.*

**Key words:** Building, Energy, Environment, Renewable, Solar.

### INTRODUCTION

The Intergovernmental Panel on Climate Change, a group of the world's foremost climate researchers indicated that more than ninety percent of most warming over the last 50 years has occurred because of human-caused emissions of heat-trapping greenhouse gases (IPCC, 2007). The IPCC further stressed that if no definite action is taken to curb greenhouse gas emissions, the global average surface temperature is likely to rise by further 1.1 to 6.4°C between 2090 and 2099.....Since some of the greenhouse gases are generated from the built environment, architects as one of the stakeholders of environment have a greater task of looking at measures of curtailing this trend. The urgency of alternatives to carbon-dioxide emitting energy sources is imperative.

One way of looking at this, is to harness renewable energy sources such as solar energy. Renewable energy sources provide a great symbol of emerging technologies for the future especially in Nigeria with abundance supply of sunlight almost all the year round. This paper examines the benefits of renewable energy sources as strategy towards adequate and affordable electricity in the built environment.

### BACKGROUND OF THE STUDY

Nigeria's energy supplies are mainly from hydro-power and fossil-fuels such as coal, crude oil and natural gas. The energy generated through burning of coal or oil for electricity results in serious environmental problems including global warming. Most of the buildings that are designed and built in Nigeria are energy dependent and rely on central public

authority for the supply of electricity. The supply comes from Power Holding Company of Nigeria, (PHCN) which began operation as Energy Corporation of Nigeria (ECN), which was later changed to National Electric Power Authority (NEPA), and to the current PHCN. Presently, Nigeria has installed generating capacity of 6,000MW and it is generating about 4,000MW because of inadequate facilities whereas daily demand is put at 5,000MW (Investors' Guide to Nigeria, 2006).

For decades, electricity in Nigeria has been in short supply. This has often manifested in prolonged power outage, intermittent power supply, ineffectiveness in service delivery and outrageous billing system. Confronted with this challenge, people more often than not, are left with no option than to complement electricity with generating sets. Ita (2003) identified that in Nigeria power supply has been complemented by personal generating sets. The relief from the generating sets though, presents serious consequence on the people and the environment.

Akanmu (2007) has identified that the increase in demand for electricity is a function of three factors - increase in population, rise in standard of living and urbanization. Every man requires a quantum of electricity in the built environment for cooking, heating or cooling, powering of appliances and for economic activities. As at present only about 10% of the rural households and 40% of the country's total population have access to electricity. (Investors' Guide to Nigeria, 2006). What does this mean to the government? How well have governments and non-governmental organizations fared in redeeming energy situation in Nigeria? What strategies are being proposed to government? This paper attempts to provide answers to the questions raised. The challenge of adequate and affordable energy for all can only be realised through renewable energy which is clean, free of emissions that can pollute environment and induce other greenhouse effects.

### RENEWABLE ENERGY SOURCES

Renewable energy is called by different names - 'Alternative Energy', 'Green Energy', 'Clean Energy', or 'Sustainable Energy'.

McNally (2001) defined renewable energy as the energy that is derived from the natural flows of energy on earth. In contrast with coal, oil and gas which are finite, renewable energy will never deplete or run out. Renewable energy include solar radiation from the sun, energy from the motion of the wind, energy from the motion of water in rivers, waterfalls, waves and tides, from biofuels and from geothermal heat.

The use of renewable forms of energy means that not only will energy be available indefinitely far into the future but also will not destroy the environment in man's quest of energy use.

The different types of renewable energy are discussed:

**Wind Energy:** Wind energy involves wind turbines usually grouped in 'wind farms' that harness the power of the wind to generate electricity. As examined by Global Wind Energy Council (2007), wind energy accounts for approximately 20% of electricity in Denmark, 9% in Spain, and 7% in Germany. However, its use may be limited to aesthetic and

environmental reasons and difficulty in integrating wind power into electricity grids in some cases.

**Hydropower:** This involves harnessing the energy of fast moving water masses by using it to spin a turbine which then powers a generator. Turbines are usually driven by water that is dammed in canals or by the natural force of the flowing river. These turbines, in turn drive dynamo principle-based electric generators, which generate electricity. Hydropower plants can exist for many years and have extremely flexible technology based on power grid operation. However, large-scale hydroelectric power systems present significant environmental disadvantages as they can cause dislocation of people where the reservoirs are sited and disruption of aquatic ecosystems and birdlife.

**Geothermal Power:** Geothermal energy is the heat in the earth which can be harnessed to provide heat and energy. For example, a geothermic heat pump can use the relatively constant temperature of the top crust of the earth to heat or cool buildings. Geothermal power is accessible only in limited areas of the world, such as United States, Indonesia, East Africa, Central America and Philippines.

**Biomass Energy:** This involves the burning of wood or crops to generate energy. This practice is often common in the rural areas where the bulk of their energy is derived from waste from agricultural and forestry operations.

**Solar Energy:** Solar energy refers to energy derived from the sun. Three areas of use of solar energy are recognized and discussed.

**Solar Water Heating:** Involves mounting solar water heating panels on the roof which then absorbs the sun's heat and can provide 50-70% of domestic hot water energy needs over a year. It basically consists of solar thermal collectors, a fluid system to move the heat from the collector to where it will be used, and a reservoir for heat storage. It can be used to heat up swimming pools, or homes and for industrial process applications or as an energy input for other use such as cooling equipment (IEA, 2008).

**Passive Solar Energy:** Involves designing and orientating buildings to optimally use the energy of the sun as efficiently as possible. This is one area in which architects have not committed serious effort as the designers serious effort of buildings.

**Photovoltaic Solar Energy:** This involves converting the energy of the sun into electricity through the use of photovoltaic cells. Solar photovoltaic (PV) technology can offer a lot of practical benefits to Nigeria considering its abundance supply of sunlight. The basic part of a solar photovoltaic cell is also known as solar cell. Solar cells are made of semi conducting materials- a thin wafer of silicon which is exposed to sunlight to produce D.C electric current. It also consists of an inverter that converts electricity into alternating current so that it can be used by most appliances and a battery which is called the charge and stores energy during overcast days. PV is environment friendly, modular, and silent, needs no fuel, and practically produces no emissions.

### **INTEGRATING SOLAR ENERGY INTO BUILDINGS**

There are two ways of realising this objective First is through Solar Photovoltaic systems and second, through Passive Solar Design.

Nigeria lies between latitudes  $4^{\circ}$  and  $14^{\circ}$ N and longitudes  $2^{\circ}$  and  $14.5^{\circ}$ E. Since the country lies in the tropics, its temperature is hot and humid most of the year. This means, there is abundant supply of radiant energy (sunlight) throughout the year. The vast majority of Nigerian people live in rural areas and most of them are without electricity. This view has also been expressed by Ita (2003) that the African continent is endowed with abundant sun, but 85% of the people 'still live in rural areas without electricity'. The reality today, is that not only do the rural communities lack access to electricity supply, the urban centres and cities are having hard times in coping with the continual power outage.

### **THE SOLAR PV APPLICATIONS IN BUILDINGS**

Solar Home System (SHS) and Photovoltaic Pumping System (PVP) are the most efficient application of PV in the household energy. However, the use of SHS is more significant than PVP.

#### **SOLAR HOME SYSTEM**

SHS has proved to be more beneficial to the rural communities especially in countries like Brazil, Senegal and India. It is especially suited to rural areas where grid power has not yet reached. Using the Solar Home Systems (SHS) in Nigeria, it will help to meet the need of lighting and electricity for home appliances such as radio, television, mobile phones and internet communication especially in this era of globalization.

The Solar home system consists of the following; PV generator; support structure; charge regulator; battery; loads (lamp, ballast, radio, TV); and wiring.

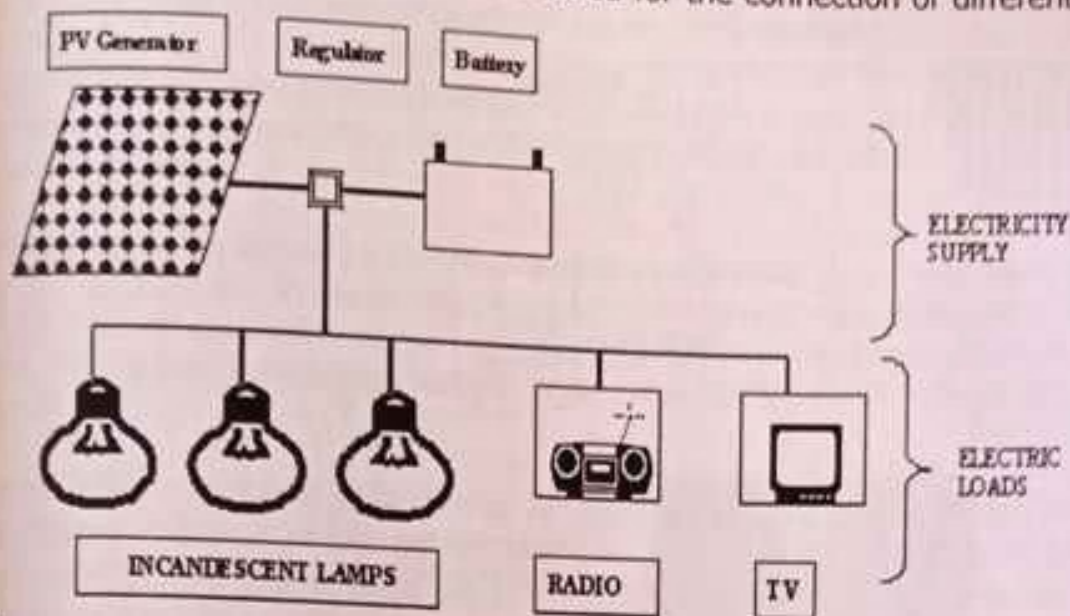
**The PV Generator or Solar Photovoltaic Cell** is the generator. It converts light into electricity. The solar cell array generally consists of one polycrystalline photovoltaic solar module. It should have a rated peak power output of at least 45 Watt peak ( $W_{peak}$ ). Its minimum acceptable operating voltage at maximum power point is no less than 16 Volts at cell operating temperature of  $60^{\circ}\text{C}$ .

**The Charge Regulator or Battery Control Unit (BCU)** serves to protect the battery against both deep discharge and overcharging. Its nominal voltage is generally 12 volts.

**The battery** stores the electric energy produced by the PV generator and can be used during overcast days.

**The loads:** radio, TV and mobile phone come directly from the users.

The wiring consisting of wire and cable is used for the connection of different elements



of SHS.

**Fig. 4.1 Solar Home System adapted from Hedon Household Energy Network**

#### **Photovoltaic pumping system**

The PVP equipment mainly comprises:

- the PV generator generally constitutes one or more polycrystalline photovoltaic solar module;
- the inverter which converts direct current (DC) into alternating current (AC)
- the pumping system;

The photovoltaic pumping system (PVP) is used for water supply, pumping for irrigation, and water for livestock need.

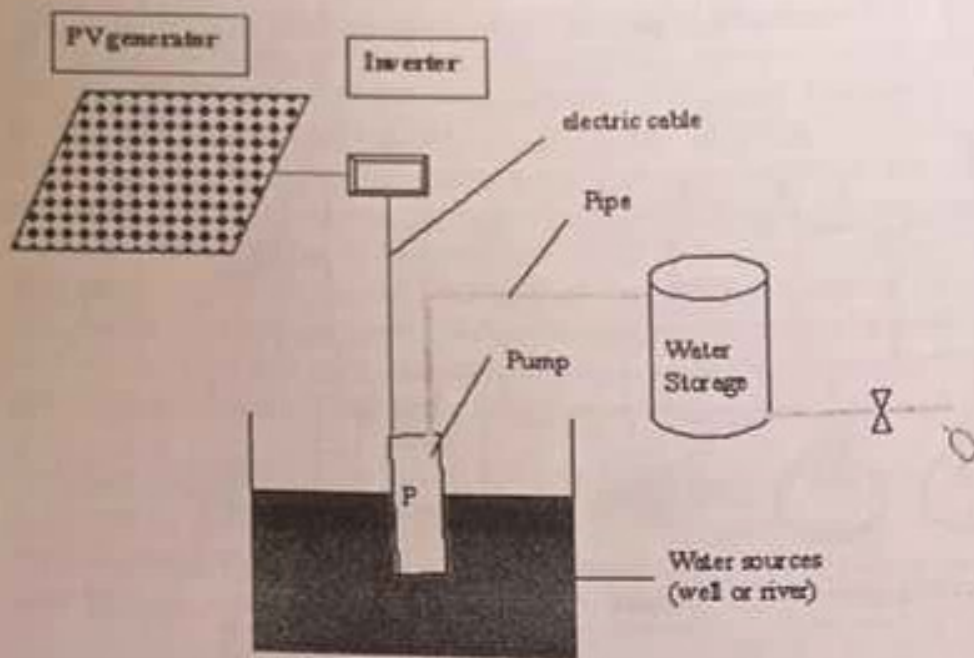


Fig. 4.2 Photovoltaic Pumping System adapted from Hedon Household Energy Network

### BENEFITS OF RENEWABLE ENERGY (SOLAR PHOTOVOLTAIC)

The benefits of renewable energy are numerous. Solar is a clean, efficient, and sustainable form of energy. The benefits are discussed below;

**Reduces Local Air Pollution:** Use of solar electric systems decrease the amount of local air pollution. With a decrease in the amount of kerosene used for lighting, there is a corresponding reduction in the amount of local pollution produced. Solar rural electrification also decreases the amount of electricity needed from small diesel generators and counterbalances greenhouse gases. Power plants air emissions are responsible for approximately one-third of nitrogen oxide emissions, two-thirds of sulfur dioxide, and one-third carbon dioxide emissions. Photovoltaic systems produce electric power with no carbon dioxide (CO<sub>2</sub>) emissions.

**Conserves Energy:** Solar electricity especially in Nigeria can be an effective energy conservation program because it conserves costly conventional power for urban areas, town market centers, and industrial and commercial uses, leaving decentralized PV-generated power to

**Improves Indoor Air Quality:** Fumes from generating sets in poorly ventilated houses constitute a serious health hazard in developing countries such as Nigeria, where electricity is not constant and in the rural areas where people still use wood for cooking. The use of solar energy help to improve indoor air quality since the fumes from generating sets, wood, candles and lamps are removed.

**Increases Effectiveness Of Health Programmes:** The use of solar electric lighting systems by rural health centres increases the quality of health care provided. Solar electric systems improve patient diagnoses through brighter task lighting and use of electrically-lit microscopes. Photovoltaic can also power televisions and VCRs to educate health workers and patients about preventative care, medical procedures, and other health care provisions.

**Increases Access to News and Information:** Photovoltaic gives rural areas access to news and educational programming through television and radio broadcasts. With the advent of television and radio, people previously cut off from electronic information, education, and entertainment can become part of the modern world without leaving their homes.

**Facilitates Wireless Rural Telephony:** Solar electricity, when coupled with wireless communications, makes it possible to introduce rural telephony and data communication services to remote villages. Solar power can help to provide power for the numerous Telecommunications bay stations around the country.

### **SOLAR ENERGY APPLICATION IN BRAZIL**

The community participation in the delivery of solar energy cannot be overemphasized. This plays a significant role in Marcei, a small coastal settlement located in Itapipoca, district of Marinheiro, Brazil.

Marcei was selected for the pilot project. Through collaboration with Solar Electric Light Fund (SELF), Institute for Sustainable Development and Renewable Energy (IDER) and Community Association of Marcei (ASCIMA), a cooperative of 520 families living in eleven communities, fifty homes were able to have access to electricity through SHS.

The pilot project was successful and the people noted the health benefits as a major drive to promote it to others. The improvements in health such as fatigue, asthma were no longer present because of elimination of kerosene and diesel fumes previously used to fuel oil lamps. The people are happy and comfortable and now enjoy the freedom that solar power lighting brings to their lives.

This initiative is also practicable in Nigeria's rural and urban centres which can go a long way in resuscitating ailing businesses and improve living conditions of people generally.

### **SOLAR ENERGY APPLICATION IN SOUTH AFRICA**

South Africa almost presents similar weather conditions like Nigeria and some of the rural areas lack access to electricity. It is also one of the countries in the world with the highest count of sunny days per year which is why solar power energy is appropriate for it. Much of her energy is derived from burning up coal and natural gas and the burning of wood in the rural areas.

Solar power is being used in number of places in South Africa for example water pumps to dams in nature reserves PV panels have also been used to power electric fencing in game reserves very successfully for interruptions in electricity is eliminated and which has prevented big mammals like elephants from breaking through a fence as could be the case in a normal power interruption.

Eskom South Africa provides the country with the cheapest conventional unsustainable electricity costs in the world, the country given her appropriate weather conditions, has embarked on more sustainable and renewable energy such as solar energy to meet its future demand for electricity.

### **THE NEED FOR ENHANCED ENERGY EFFICIENT BUILDINGS**

Energy affects all aspects of building design, construction and operation from drawing of initial plans to installations of equipment and appliances in a building (Mohammed, 2007). In order to reduce greenhouse gas emissions from homes and buildings, there is the need to shift to an approach that enhances energy savings and make buildings more energy efficient. Day lighting and passive solar heating are the commonly - used approaches to energy saving techniques.

Passive solar design involves a conscious integration of building elements for optimal energy performance whereby the building interacts with the outdoor environment. Passive solar building can utilize the energy of the sun with south facing windows and installing photovoltaic cells on the roof top. Hassan (1986) as captured in Haruna (2007) echoed the importance of passive solar design, building shape and orientation and natural lighting as measures that can influence building energy performance. The architect should as a matter of policy, design buildings that will be more efficient in terms of energy use and conservation in order to promote sustainability in the built environment.

### **RECOMMENDATIONS**

This paper recommends the following:

1. Government should bring out a policy that will encourage the deployment of renewable energy technologies in Nigeria to complement ailing power company.
2. Create local awareness and adequate information dissemination for renewable energy such as solar photovoltaic energy. The awareness is of great importance now as many small scale businesses could be made to flourish through renewable energy sources rather than rely on generators which promote health risks.
3. Encourage participation of stakeholders, non - governmental organizations and community participation and cooperation in renewable energy projects through setting up of pilot projects in rural areas.
4. Funding research on new technologies to bring down costs of installing renewable energy technologies.
5. Collaboration with other countries or organisations in the areas of education which includes adequate scientific, technical and manufacturing skills required for renewable energy production in Nigeria.



## CONCLUSION

This paper has examined the benefits of renewable energy sources in the built environment. It highlighted the power situation in Nigeria with the result that almost the entire cities in the country and households are grappling with acute shortage of electricity on a daily basis. The paper recognizing the abundance supply of sunlight in the country suggested solar photovoltaic as an alternative to the nuclear energy which if properly harnessed can bring much benefits through reduction of hazardous emissions in the built environment. The paper recommends enlightenment of the public to the benefits of renewable energy and community based participation towards the delivery of solar energy to the rural areas as well as in the urban centres.

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