SOLAR ENERGY IN NIGERIAN BUILDINGS: A PATHWAY TO ENERGY EFFICIENCY

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ABSTRACT

Due to the increase in living standard and demand, energy conservation has become important in industrialized and developing countries. In respect to rational use of energy, this paper evaluates solar energy in Nigerian buildings with the aid of passive and active solar architecture approaches which makes use of specific building design principles and reduces the artificial energy requirements for achieving indoor thermal comfort. As a climate responsive architecture, building design criteria has been studied with the help of several parameters like geographic location and climatic conditions, building shape, orientation, selection of construction materials, building openings viz. windows, selection of suitable sunshades, etc. All the salient building design parameters are studied and important findings and recommendations are suggested as the outcome of the study. In our quest for sustainable development and the achievement of a safe environment, numerous alternatives to power supply have been exploited. The challenge of erratic and insufficient power has for decades bedeviled our dear nation resulting in the proliferation of the use of generators in multiple locations within the built environment. This solution apparently is the people's response to the nations decaying infrastructure but invariably produces an environment which is unsafe to its inhabitants. In recent times, reports have shown

that the emissions arising from this practice have caused the death of occupants. It is common knowledge that the use of solar energy as an alternative power source is not yet ubiquitous in this country. In recent times, innovation in the area of thermal solar and photovoltaic provides possibilities of its introduction in the building fenestration and facade. This study however examines some existing solar powered facilities in Nigeria. The study is useful for various resource persons involved in construction activities for designing energy efficient buildings.
Keywords: Solar Energy, Environmentally friendly, Passive and Active solar.

INTRODUCTION

Solar Energy or Sunlight as it were has been an integral influence in building designs since the inception of architectural history. Frank Shuman an American Inventor, Engineer and solar Energy pioneer who built the world's first solar thermal power station in Maadi Egypt has this to say "We have proved the commercial profit of the sun power in the tropics and have more particularly proved that after our stores of oil and coal are exhausted the human race can receive unlimited power from the rays of the sun".(Shuman, 1916). In corroborating what Shuman said in July 2, 1966, the fossil fuels which provide the bulk of energy Nigeria consumes at present are still thought as cheap alternatives to actions, ignoring the fact that coal, gas and oil are finite resource with limited life for the future, leading to potential energy crisis if solar energy is not exploited. The reduction in the use of energy in buildings has been identified as a major objective,

of which electrical lighting is a significant factor, the need for stable and constant power supply in Nigeria today where Power Holding Company of Nigeria (PHCN) has made the electricity supply the alternate to generator has actually called for more reliable and effective means of power generation. The sun, the main source of energy on earth produces energy free of charge and practically endlessly. This energy can thus be converted to use in architecture.

Solar Energy Defined

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air.(Aina, 2010). The large magnitude of solar energy available makes it a highly appealing source of electricity.

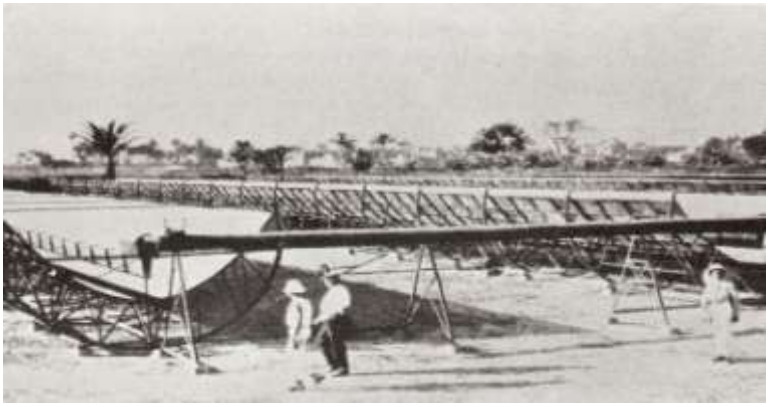

Fig 2.1The First Solar Engine in 1897 by Frank Shuman

In 2011, the International Energy Agency said that the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower The costs of mitigating global warming, and keep fossil fuel prices lower than otherwise. These advantages are global. Hence the additional costs of the incentives for early deployment should be considered learning investments; they must be wisely spent and need to be widely shared.

Solar Energy in Buildings

Solar Energy in Buildings presents solar radiation fundamentals and their applications in buildings, supported by theoretical analysis and results of original simulation studies in solar energy availability, collection, and conversion for both active and passive use.(Chwieduk, 2014). In-depth coverage of energy balance and heat transfer in building envelopes is supported by the inclusion of calculations and case studies, while contextualizing within an

integrated design approach. It is almost impossible to talk about solar energy in buildings without bringing building orientation to the fore. Dependent on what is to be achieved either minimizing heat gain or maximizing it the building is meant to take whatever orientation the architect deems fit. However, in areas where there is a cluster of buildings probably shielding some other buildings from direct sunlight making it almost impossible for building orientation to be exploited to the fullest, other means of solar energy could be harnessed.

Fig. 3.1: German solar city produces four times more energy than it uses. German architect Rolf Disch one-upped them all by creating an entire solar city. Sonnenschiff in Freiburg is a small community that is entirely powered by theSun, with rooftop solar panels everywhere you turn. Combined with Passivehaus principles that utilize energy efficiently, the city can generate up to four times as much electricity as it needs.

Harnessing Solar Energy

Solar energy is a renewable source and many technologies can harvest it directly for use in homes, businesses, schools and hospitals. Some solar energy technologies include photovoltaic cells and panels, concentrated solar energy, and solar architecture. Some of the ways by which solar energy can be used in the through the aforementioned technologies are:

a. **Electricity generation**: Electricity can be generated from solar energy in two ways – the direct conversion by photovoltaic or thermoelectric processes. Alternatively, solar energy can be used to produce mechanical work which will then be used to drive electric generators.

b. **Water heating**: solar panels produce energy that heats up water in a water heater for domestic use in the kitchen and bathroom. In swimming pool, it is done by using thermo-siphon principle. The water is heated in the collector, rises and is replaced by cooler water.

c. **Cooking**: solar energy can be used for cooking using either the direct (focusing) cooker or the box (oven) type solar cooker. In the focusing cooker, the pot containing the foodstuff is placed at the focus of a parabolic mirror. The solar oven is an insulated chamber with a window on one side to admit radiation.

d. **Distillation**: distillation of non-potable water for drinking using the box type distiller.

e. **Space heating**: this is the use of solar energy for heating of buildings through the use of buildings as collectors or the use of special building elements or collectors.

f. **Space cooling**: this can be done through mechanically driven compression type refrigeration or by using absorption type refrigeration.

The energy to run these plants is obtained from the sun.

g. **Drying**: drying of various agricultural crops or products is achieved through exposing them to the sun in a covered tray of some sort or by blowing hot air through or over them.

There are different ways of capturing solar radiation and converting it into usable energy. The methods use either active solar energy or passive solar energy.

Active and Passive Solar Energy in Buildings

Passive solar designs refer to the use of the sun's energy for the heating and cooling of living spaces by exposure to the sun. When sunlight strikes a building, the building materials can reflect, transmit, or absorb the solar radiation. In addition, the heat produced by the sun causes air movement that can be predictable in designed spaces. These basic responses to solar heat lead to design elements, material choices and placements that can provide heating and cooling effects in a home. Unlike active solar heating systems, passive systems are simple and do not involve substantial use of mechanical and electrical devices, such as pumps, fans, or electrical controls to move the solar energy.(Tournemille, 2010).

Active solar designs on the other hand refer to the use of outside energy equipments like electricity or solar panels to help capture and utilise energy from the sun. Some examples are:

- Collecting sunlight through rooftop panels and transferring its energy to a hot water boiler for household use.
- Pumping solar-heated water into a system of pipes embedded into concrete slab floors to

transfer heat throughout the home (known as radiant floor heating).

- Hot water baseboards can also use solar-heated water to help distribute heat throughout the home.

Fig 5.1.1: The spinning, sun-chasing Heliotrope designed by Rolf Disch. It can generate up to five times as much power as it needs to operate. The home sports a giant angled solar array on the roof and the entire structure is mounted on a pole timed to rotate 180 degrees each day as it follows the sun.

Both active and passive solar energy are excellent choices in areas with lots of sun and cold weather – like Long Island! Harnessing and transferring solar energy is a cost-effective alternative to using traditional (and expensive) heating sources like electricity or oil, which most of us here on Long Island pay for dearly in the cold winter months.

With active solar heating systems, those bills can be greatly reduced, since we might only need to rely on electric or oil heat as a back-up energy

source, rather than our only energy source. And when a home is designed for immense energy efficiency, it can even reach the point of becoming a net zero energy home, producing as much or more energy than it needs!

Challenges of Solar Powered Buildings in Nigeria

The price of crude oil has quadrupled in the international market since the mid 1990s till date. This has had impact on the automotive, manufacturing, building industries creating a shift of focus to renewable energy sources. The global concern on Climate Change also poses a challenge on the design, sustenance of safer and cleaner environment. The creation of a future devoid of uncomfortable condition, pollution, and poor living standards has arisen from this concern. The initial capital investment for alternative power supply using solar systems is observed to be enormous but on the long run it offers such advantages as quiet operations, environmental friendliness, maintenance free operations and high reduction in cabling for external lighting. However this study revealed that a number of challenges are militating against the success of the solar alternative power supply. The challenges include but are not limited to the following:

a. The quality and conditions of components if not properly ascertained before installation may affect operations adversely.

b. Lack of a well structured maintenance programme for the installations. Technical officers who understand the operations of the systems know the critical areas that should be monitored.

c. Proper installation of the PV panels determines the amount of power collected. Many believe that the roof top is the

best position for installation irrespective of the designed slope of the roof.

d. Most installations are not considered at the design stages of buildings therefore resulting in land wastage and low efficiency of the systems.

e. One of the major deterrents against solar energy in Nigerian buildings is the solar technology equipment which is quite expensive in its purchase and installation for individual homes. Although the government often offers reduced taxes to people and businesses using solar energy and the technology can eliminate electricity bills the initial cost is still steep for many to consider.

CONCLUSION

Integration of solar panels in residential architecture in Nigeria to generate electricity will reduce the problem associated with electricity supply by PHCN and makes homes seeking minimum comfort and convenience achieve it without much fuss. The most basic solar electric system for a family would be a single solar panel, charge controller, battery and inverter depending on the energy requirements of the residence. In the past five or six years, there is a high demand for the rapidly developing solar electric industry which serves as alternative to the epileptic energy supplied by PHCN.

A solar electric system consultant should be retained to design and install the system. Electrical contractors, who are able to size and install the wiring for an alternating current system, are often familiar with direct current systems. Some solar equipment sales companies offer training for people who are interested in learning to install their own solar electric system.

Government should encourage Nigerians and enlighten them on the use of solar panels in electricity generation by crashing the cost and thereby helping in achieving the Government target of providing stable electricity in the country.

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