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ENVIRONMENTAL SOLAR ENERGY TECHNOLOGY NEEDS IN NIGERIA

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ABSTRACT: *Solar energy technology and development in Nigeria is still at its rudimentary stage. The population is very optimistic that solar energy would offer a great alternative to the nation's overall energy needs. Nigeria is well located within the humid tropics and equatorial axis with abundant sunshine, high radiation intensity, vast open spaces for areal energy capture and great opportunities for solar energy technologies. Experiences from some advanced countries of the world like USA, Australia, Germany and Switzerland indicate that a solar energy plant is capital intensive and requires large areas of capture. Solar energy, as a renewable natural energy resource offers mankind with variety of direct and indirect solar energy technologies. The direct solar energy varieties include photovoltaic and solar thermal, among others, while the indirect solar energy varieties include hydropower, wind power and so on. In general, the country is in great need for solar energy varieties for her domestic, commercial, educational, agricultural and industrial energy needs.*

KEYWORDS: *Environment, Solar, Energy Technology, Nigeria*

INTRODUCTION

Solar energy needs in the country is expected to supplement the available energy sources already existing but poorly developed and under-utilized for obvious reasons. The very issue of underdevelopment results in the under-utilization of our natural energy resources from fossil fuel reserves-coal, oil and natural gas. The energy contained in fossil fuels is theorized to originate from the sun's energy, which was stored up in plants millions of years ago. The fossil fuels formation over the geologic era existed for some 60 to 600 million years ago beneath the earth surface. The intensive pressure and temperature converted organic matter-plants and animals, after series of biological, chemical and physical reactions to obtain the oil-petroleum, gas and coal as trapped in geologic rock strata (Mayer, 2001).

The fossil fuels, particularly the coal resources, played a leading role in the industrial revolution of the 18th century Europe and later became useful in other parts of the world until the discovery of crude oil and natural gas. Obienusi (2004) dealt extensively on the regional distribution of environmental resources across the globe. There have been great developments in energy resources among the developed countries, notably in the areas of hydroelectricity, thermal generators and nuclear energy supplies.

However, the issue of energy crisis occasioned by uneven concentration of fossil fuels throughout the earth surface, exhaustible nature of the non-renewable energy resources and the global concern over the environmental pollution arising from the utilization of several energy resources; nuclear power reactors, coal-fired turbines, oil and gas combustion, necessitated the need to develop solar energy technologies for the use of mankind. In this study, we review briefly the solar energy resources concept, the global solar energy resources utilization and Nigeria's solar energy potentials. We also recommend various ways of achieving solar energy needs of the country.

MATERIALS AND METHODS

The bulk of the materials needed are of space technology data acquisition. The United States and former Soviet Union sponsored manned and unmanned space travels in the 1960s provided close-up views of the earth-centred universe. The massive data obtained from the various interplanetary space probes of the late 1960s and 1970s were used. The National Space Research and Development Agency (NASRDA), Abuja provides scenes of Nigeria Sat-1. The meteorological data derivates from Remote Sensing across the country provide information on solar radiation and outer space characteristics. Several other materials on current achievements and development in solar energy technologies may be sourced from the internet, publications and journals. The United Nations and European Space Agency, among others provide useful information on solar energy resources and the emerging benefits to the international communities. The geographical and meteorological interpretation techniques were used in the study.

Solar Energy Resources Concept

The earth-centered universe comprises of the solar system – the sun and the nine planets. Apart from these planets, there are several millions of stars in the sky. The sun is believed to be part of the enduring stars. This observation was partly explained by the "big bang" theory. The stars are separated from the sun by the continuous activities of the spinning nuclei of hydrogen and helium formation. The eternal state continuous creation as explained by the theory led to the creation of the planets (Kopal, 1972; Ryan, 1978). The clusters of these stars in the solar system are referred to as the galaxies. The earth's own galaxy, also known as the Milky Way galaxy is the only planet that has life – human, animals, plants and all living organisms (Brandwein et al, 1970).

The sun's energy illuminates the earth with renewable energy. It must be recalled that other planets including the earth, revolves round the sun in an elliptical orbits, thereby introducing variation in the amount of isolation received from the sun. Essentially the sun's energy reaches the atmosphere and the earth's surface as sunlight. The energy built-up of the sunlight reaching the earth is constant, usually called solar constant, with a value of 1367 watts/m^2. However, due to earth's rotation and revolution, the amount of sun's energy intensity varies greatly with latitude, time of day, and season of the year (Barry and Chorley, 1976, Danielson et al, 1998). The partial or total solar eclipse of the moon, volcanic dust and such other atmospheric dust also may introduce variation in sunlight duration and intensity. Okpala (2005) discussed the history of total solar eclipses in Nigeria. The sequence of occurrence of such solar energy alteration in the country is a good design variable in solar energy technology manufactures.

The sun's energy, by its nature has renewable and sustainable energy flow to the earth's surface. This single quality assures man of an endless energy supply if properly harnessed. The solar radiation to the atmosphere and the earth's surface maintains a favourable radiation budget at the top of the atmosphere, except perhaps for the ozone depletion by man (Monastersky, 1994). However, there are little or no environmental disequilibrium reports on the direct solar energy harvesting for man's various energy needs – economic, commercial, domestic, agricultural and educational activities.

In general, solar energy is a good example of intangible renewable natural resources. It is available to man at varying degrees or concentrations, depending on the latitudes, for example. At locations within the equatorial axis, the solar beam is well concentrated. At the mid-latitudes and the poles, inclination of the earth causes the sunlight to strike the earth's surface at lo or very low angles, resulting in low or very low energy concentrations per unit time. At global level, much had been recorded in the development and utilization of solar technologies.

Global Solar Energy Resources Utilization

By the 1980s, speculations were high on the possibilities of harvesting solar energy. The report of the second United Nations Conference on the exploration and peaceful uses of outer space in 1982 maintained a common application of space science and technology among the nations. The conference agenda expressed the use of appropriate measures to augment the capabilities of developing countries access in space technology and its application (UN, 1982). The conference remarked that even though space Solar Power System (SPS) is unlikely to be a reality before the end of 20th century, its visionary relevant cannot be questioned in the context of growing world-wide energy needs and dwindling energy resources – the fossil fuels.

The visionary argument was much among the various countries of the world. It is therefore not uncommon that space solar power system technologies have been developed and utilized for the various energy needs of man before the end of the 20th century. The millennium achievements of the 2000s in the solar energy resources utilization across the globe are tremendous. In Appendix A, list of installed photovoltaic capacities as at the end of 2001 across the world is shown. The solar energy utilization for the continents of Africa, Europe, Asia, North America, South America and Oceania is shown in Fig. 1 as derived from Table 2.

In Africa, Morocco and Egypt ranked first and second in solar energy utilization. Nigeria has no record of any meaningful photovoltaic installation as of the time. However, by 2014, various states in the country had acquired and mounted photovoltaic installations for urban beautification projects. In Anambra State, for example, all the 21 local government areas of the state had few of such installations at strategic locations. The spatial distribution of higher kilowatt photovoltaic installations are found in Asia, Europe, North America, Oceania, Africa and South America in that order, see Figure A, as derived from Appendix A. Japan ranked first, with a capacity of about 205,000 kilowatts (KWp) followed by United States and Germany with installation capacities of about 117300 and 65500 kilowatts (KWp) respectively (WEC, 2001).

The photovoltaic technology is really getting popular, working silently, not polluting and is so designed to generate electricity wherever the sun shines. The photovoltaic cells generate the power that runs space satellites, telecommunication satellites (GSM masks) and in many others uses – domestic, educational and commercial uses. Charters (1997) gave a general classification of solar energy technologies based on direct and indirect solar resources as shown in Table 1.

In California, a 10-MW solar thermal project was completed in 1996. Essentially in this project, water is superheated to steam by the solar energy. The superheated steam is now channeled to a power turbine or electric power generator for electricity power generation and distribution (Mayer, 2001). Several success stories abound on solar energy harvesting across the globe. In Poland, solar energy is stored in the ground. Chwieduk (1994) explained that during the sunny days – summer season, the heat from the solar system is transported to the ground store through a fluid heat exchangers system. Then, during the winter season, the ground stored energy is unloaded and distributed to heat churches, shopping centres and households, among others.

Boer (1995) emphasized that solar energy harvesting may be capital intensive but it offers great energy both in the urban and rural areas. In Nigeria, the inefficient hydropower generation at most of the power stations is of a great worry to the government, industrialists and the general public. Recently, the federal government offered for privatization the Afam Power Station, Oji, Enugu State. The issue of privatization should be extended to investors in solar energy development in Nigeria.

Nigeria's Solar Energy Potentials

The country lies within equatorial axis, where sunlight intensity is very high. Oguntoyinbo (1982) commenting on insolation and radiation in Nigeria, noted that, "seasonal variation in the length of day in Nigeria is not great". The maximum possible hours of sunshine vary between 12hours 25minutes in the south and 13hours 1minute in the north during June; in January these values range from 11hours 15minutes in the north to 11hours 55minutes in the south. The actual totals of insolation received at the earth's surface are substantially reduced, mainly by cloudiness, whose effect is most marked in the south, due to the nearness of the Atlantic Ocean and the persistent influence of humid south-east winds; yearly sunshine values here lie between 45% and 55% of the maximum possible (Oguntoyinbo, 1982).

The basic requirements for solar energy harvesting as explained by Oguntoyinbo (1982) is available in the country – abundant sunshine all the year round. Several pressure groups, such as the solar energy society of Nigeria are very optimistic that investing in the Solar Energy Development will be of great benefit toward solving energy needs of the country.

Considering the urban and rural population of the country, there is potential market for solar energy technologies. The 1991 national census indicated a total population of about 89million people. By 2009 and 2011, the populations were estimated to be about 152.6 and 162.3 million people. The urban population constituted about 47% while 53% is rural (PRB, 2009, 2011). The present energy demand in the country is much. The urban and rural electrification programmes have not achieved much in energy distribution in the country. Several rural areas in the country have not benefited from the rural electrification policies of the country. Several small and medium scale industrial establishments are closing don due to poor electricity supply. The continued dependent on generators for industrial manufacture affect the overall production cost; leading to high cost of goods.

The story is not different in the domestic, educational and commercial energy needs. Some of the Nigerian universities are not connected to the national grid and the use of poor lighting is not a healthy development for the students Agbo et al (2005) observed that solar energy development in Nigeria is possible, considering a pilot solar energy technology monitored at the Energy Centre in the University of Nigeria, Nsukka. Several encouraging reports on research breakthrough come from other universities and polytechnics spatially located in the country. Sanusi and Aliyu (2005) reported that solar radiation model used in the estimation of mean monthly global solar radiation in Sokoto is reliable. Sokoto is located in the northern part of the country, with several hectares of land spaces for sitting solar energy projects. Other locations abound in the middle belt region of the country, most especially when considering solar thermal projects. The encouraging efforts of the National Space Research and Development Agency (NASRDA) in space related studies in Nigeria are commendable. Awareness and general sense of commitment by the people is crucial now.

CONCLUSION AND RECOMMENDATION

Njoku (2005) expressed the need to popularize the utilization of solar energy technology in Nigeria. This is true, mainly due to lack of information about the available solar energy technologies. The Nigerian population is in dare of energy supplies. When greater awareness on the solar energy technologies is undertaken both the government and the general public will make it a number one political project. Osuji (2003) expressed the need for sensitizing the Nigerian populace about the development in renewable energy sources, including the solar energy. He noted that at the primary and secondary schools levels, little or nothing is done in the form of formal education in renewable energy.

It must be noted that in planning for the development of solar energy technologies in the country, there is need to develop human resources to work in such projects. The Solar Energy Society of Nigeria and the Energy Commission of Nigeria are expected to do more in policy formulation in matters of space technology. In the industrialized nations, specific policies on solar energy development were implemented and the benefits of solar energy utilization are so much for them.

United Nations has always encouraged international cooperation and bilateral agreements in issues beneficial to mankind. There is the need to examine the existing infrastructure and scientific and technological development in various countries, especially the developing countries, such as Nigeria and design appropriate measures to argument the efforts being made so far in space technology and usefulness of its applications in these nations. Morocco, Egypt, South Africa and Senegal, for example had installed photovoltaic plants in their regions.

Recently, the deregulation of telecommunication in Nigeria, ushered in the establishment of several Global System for Mobil Communication (GSM) operators in the country. These telecommunication operators, such as Globacom, MTN, V-mobile and several others, were able to distribute their services to the population by constructing several telecommunication satellites across the regions which are being powered by the photovoltaic cells. The benefit of solar energy technologies in Nigeria will continue to be much. There is solar energy technology needs in the country at various levels of economic activities – agricultural, industrial, commercial, educational and domestic levels, among others.

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APPENDIX A

Table 1: General Classification of Solar Energy Technologies

S/N	Solar Direct	Solar Indirect
1	Photovoltaic	Hydropower
2	Photochemical	Wind Power
3	Photogalvanic	Biomass Power
4	Solar Thermal	Solar Thermal Power

Source: Charters, 1997.

Table 2: Global Photovoltaic Installation Distribution, 2001

S/N	Continent	Country	Installed Capacity, KWp
1	Africa	Morocco	3,000
		Egypt	2,000
		South Africa	1,160
		Senegal	1,000
		Botswana	600
		Ghana	196
		Switzerland	60
2	Asia	Japan	205,000
		India	44,000
		China	8,800
		Indonesia	5,000
		Thailand	4,600
		Korea Rep.	3,459
		Nepal	1,122
		Philippines	217
		Turkey	150
3	Europe	Germany	69,000
		Italy	18,475
		Switzerland	13,400
		France	9,121
		Netherlands	9,105
		Spain	9,080
		Norway	5,670
		Austria	3,672
		Sweden	2,584
		Finland	2,302
		United Kingdom	1,131
		Denmark	1,070
		Portugal	503
		Slovenia	50
		Croatia	10
		Czeh Rep.	10

		Romania	6
4	North America	United States	117,300
		Mexico	12,922
		Canada	5,826
5	South America	Argentina	5,000
		Bolivia	470
6	Oceania	Australia	25,320

Source: WEC Survey of Solar Energy Resources, 2001.