Harnessing Energy from the Sun

Oladeji, J.T.

Mechanical Engineering Department, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso
research222a@gmail.com

Abstract: Nigeria's vision of becoming one of the twenty richest economies in the world by year 2020 will be a mirage, unless the issue of epileptic power supply is resolved. This could however be overcome by utilizing energy from the sun, which is very abundant in the country, Nigeria being a tropical country. Solar energy is the most promising of the renewable energy sources in view of its apparent limitless potential. This study therefore investigated the potentials of energy generation from the sun. The materials used were solar panel, inverter, battery, solar charger controller and solar panel stand. They were coupled together. Four positions of panel were selected and these were; when the panel was at parallel to the horizontal and stationary, when it was inclined at 15°, 30° and 45° respectively. Readings of generated current at various angles of inclination of solar panel were recorded and exact location of the panel was determined through compass. The average currents recorded at 15°, 30° and 45° were 4.67, 4.89 and 4.97 amperes respectively, while the current generated for stationary panel when it was parallel to the horizontal was 3.96 amperes. The results showed that improved current generation was obtained when the panel was facing south. The study concluded that having a rotating solar panel is far better than the stationary one and that, the maximum current, which translates to high power was recorded at angle of inclination of 45 degrees.
[Oladeji, J. T. **Harnessing Energy from the Sun.** *Rep Opinion* 2013;5(6):5-9]. (ISSN: 1553-9873). http://www.sciencepub.net/report. 2

Keywords: Solar energy, solar panel, inverter, battery, current, power

1. Introduction

To say that electricity is in short supply in Nigeria is an understatement, it is simply not there and the importance of continual supply of electricity cannot be over-emphasized. This is because; it forms the foundation for industrial growth of any nation. It is also required in homes for various domestic purposes and applications. Vision 20:2020 will be a mirage, unless the issue of epileptic power supply is properly addressed (Oladeji, 2011a).

At present, majority of energy resources in Nigeria are still from firewood and fossil fuels such as coal and oil and this will inevitably lead to continuing deforestation, depletion of other energy resources and emergence of adverse environmental impacts (Akintola and Alamu, 2010;Oladeji, 2011b;Oladeji, 2012). The growing energy needs and increasing environmental concern have prompted investigation into alternatives to the use of non-renewable and polluting fossil fuels (Jekayinfa and Scholz, 2009; Oladeji, 2011c). The sun is the primary source of energy. The sun produces an enormous amount of light 3.83×10^{26} Watts of power in the form of light (Osueke and Ezugwu, 2011). In comparison, an incandescent lamp emits 60-100 watts of power. The temperature of outer, visible part of the sun is 5500°C (Bala, et al., 2011).

The energy acquirable from the sun is termed solar energy. It is the sun's rays (solar radiation) that reach the earth. Solar energy can be converted into other forms of energy, such as electricity (photovoltaic) and heat (photo-thermal). This energy when properly harnessed can be put to constructive uses, such as generating electricity for household appliances, cooling and heating.

Electrical energy uses the power of the sun to produce electricity through solar cells, otherwise known as photovoltaic (PV) and it can be applied in three ways, as follows: Stand-alone, Grid-connected and Back-up. A photovoltaic cell is a device used for the conversion of the sun's ray into electricity. Photovoltaic system consists of solar panels, a battery, a charger controller, and an inverter. The lifetime of the panels is typically 20 to 25 years, which is considered the lifetime of the total system. The battery allows power to be supplied at night or during cloudy weather. Two types of battery can be used, deep-cycle and starter batteries. Deep–cycle batteries are more efficient and most commonly used, but starter batteries are already available in Nigeria due to their use in cars. A deep cycle battery last between three and eight years. The charge controller regulates the current added to and drawn from the battery in other to maximize the battery lifetime and for user safety (The National Academic Press, 2007). Because photovoltaic system produces a direct current, the inverter is necessary only if the end uses of electricity require an alternating current.

The design of a photovoltaic system must balance the rate of solar energy deposition on a given area with the power required by the load. The measure of total solar irradiance commonly used to assess the

input for photovoltaic panels is daily peak sun hours and the number of daily peak sun hours is equal to the value in kWh of the total amount of direct and diffuse solar radiation incident on a square meter in a day (Types of renewable energy, 2010).

Of all the renewable energy sources available, energy generation from the sun (solar energy) presents itself as the most outstanding in that only in solar power do we find the potential for an energy source capable of supplying much more energy than is used (Babatunde, 1998). By estimation, the amount of energy that falls to the Earth's surface in a single minute is enough to meet the world's energy demands for an entire year (Chendo, 2002). The earth receives 174×10^5watts of incoming solar radiation (insulation) at the upper atmosphere (Smil, 2003).

Solar energy is one of the major options for a sustainable fuel source that will allow a switch to a carbon neutral energy economy. Electricity generation from solar energy is rapidly spreading, but it needs transport and storage to balance production and demand. At present 70% of worldwide energy use is based on fossil fuels (Kaygusaz and Turker, 2002). The efficient conversion of solar energy to a useful fuel requires more research and development. In particular, finding a fuel for a smooth transition to a carbon neutral transport sector is a difficult challenge.

There are many advantages derivable from utilizing energy from the sun. Some of these are:-

(i) The issue of inconsistence in electricity supply will be taken care of.

(ii) It offsets utility supplied energy consumption, since it does not only reduce electricity bill, but continuously supply homes and business.

(iii) There will be cleaner environment as there will be no pollution of air.

However, some limitations or constraints have been identified as being responsible for the slow pace of growth of solar energy. Some of these constraints are:-

(iv) A basic barrier to the development of solar energy technology in Nigeria as a developing country lies in high initial costs and long payback times.

(v) Though, the technologies for harnessing solar energy are being developed in Nigeria, most components have to be imported, which further pushes the investment costs higher. Governments should encourage research into this area locally.

(vi) There was virtually no comprehensive energy policy in Nigeria until very recently.

(vii) The level of awareness about the immense socio-economic and environmental benefits derivable from solar energy is very low in Nigeria. The current flow of information about the development, various applications, dissemination and diffusion of solar energy resource and technologies is inadequate.

(viii) There is definite need for capacity building and training both at institutional and personnel levels.

Solar energy has been utilized in Nigeria in various forms: namely, solar PV for rural electrification, solar cooker, solar crop dryer, solar manure dryer, solar water pump, solar water heaters, solar chick brooders etc. Notable solar projects in Nigeria include: street lighting in Ado Ekiti, Ekiti State, 7.2kW Kwalkwalawa Village Electrification, Sokoto State and 1.87 kW Iheakpu-Awka Village Electrification/TV Viewing, Enugu State among others (Awogbemi and Komolafe, 2011) .

Nigeria, situated approximately between 4^0N and 13^0N and with landmass of 9.24×10^5 km^2 is endowed with an annual average daily sunshine of 6.25 hours, ranging between about 3.5 hours at the coastal areas and 9.0 hours at the far northern boundary and an annual average daily solar radiation of about 5.25 kW/m^2/day at the coastal area and 7.0 kW/m^2/day at the northern boundary (Bala, et al, 2003). Consequently, Nigeria receives about 4.851×10^{12} kWh of incident solar energy per day or an average of 1.804×10^{15} kWh annually (Chendo, 2002). This annual solar energy value is about 27 times the nation total conventional energy resources in energy units and it is over 117,000 times the amount of electric power generated in the country (Osueke and Ezugwu, 2011). These are huge energy resources. However, due to the movement of the earth relative to the sun, the direction or angle at which the rays reach the earth surface changes from sunrise to sunset and this greatly affects the intensity of radiation**.** To solve this problem, solar manual tracking is introduced in order to move the panel in more than one direction, which involves human control in order to provide optimum solar energy at different time intervals. Therefore, the main objective of this work was to improve energy generation from the sun through the tracking solar panel.

2. Materials and Methods

The component parts used were 80 Watt photovoltaic module (solar panel) that is capable of delivering adequate current to a battery was used in order to get the desired output power, an inverter, battery (100AH) to store energy, regulator/charger circuit to protect the battery from overcharging, wire and cables for connection of parts and components, and solar panel stand to carry the solar panel. They were all procured at various electronic markets. Materials used for solar panel stand were selected based on the cost, durability and availability. They were coupled together (Figure 1.0). Various positions of the solar panel were considered. Specifically, four positions of panel were considered and these were, when the panel was stationary and parallel to the horizontal and when it was inclined at 15°, 30° and

45° respectively. Readings of generated current at various angles of inclination of solar panel from 12.00 noon to 4 pm at 20 minutes interval were recorded and tabulated.

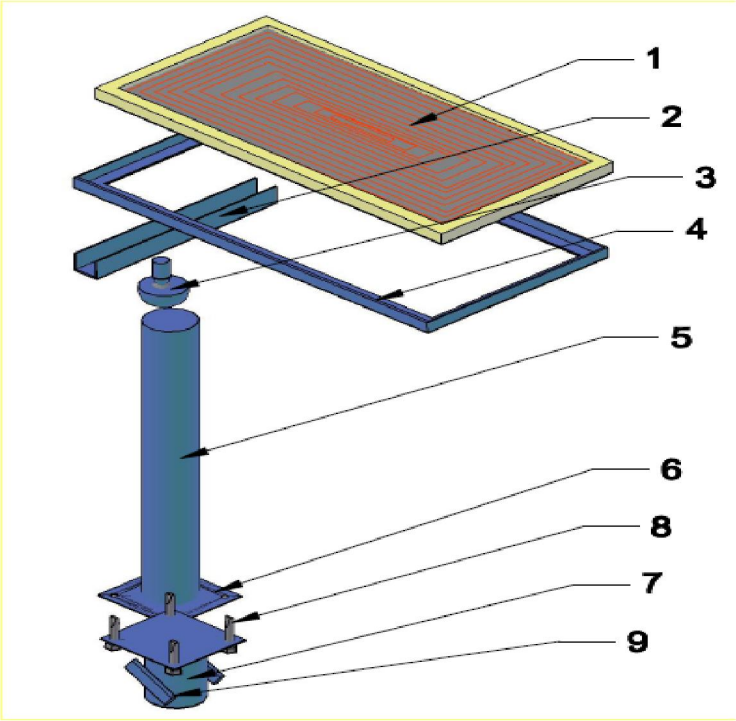

Plate 1. Solar Panel with a tracking device

LEGEND

1 Solar Panel
2 Supporting Frame
3 Ball Bearings
4 Frame
5 Base Shaft
6 Base
7 Underground Base
8 Bolts and Nuts
9 Cross Bar

3. Results and Discussion

Table 1 shows results of power generated at various positions of the solar panel.

Table 1. Results of voltage and current readings from 12 noon to 4 pm

Position of solar panel	Mean Values of 13 readings from 12.00 noon to 4pm at interval of 20 minutes		
	Voltage (V)	Current (A)	Power (W)
Stationary and parallel to the horizontal	18.515	2.736	50.65
15^0	18.877	3.305	62.39
30^0	19.30	4.276	82.53
45^0	19.154	4.518	86.54

The results showed that improved current generation was discovered when the panel was facing south. The average currents recorded at 15°, 30° and 45° were 4.67, 4.89 and 4.97 amperes respectively, while the current generated for stationary panel when it was parallel to the horizontal was 3.96 amperes. This is depicted in Figure 1

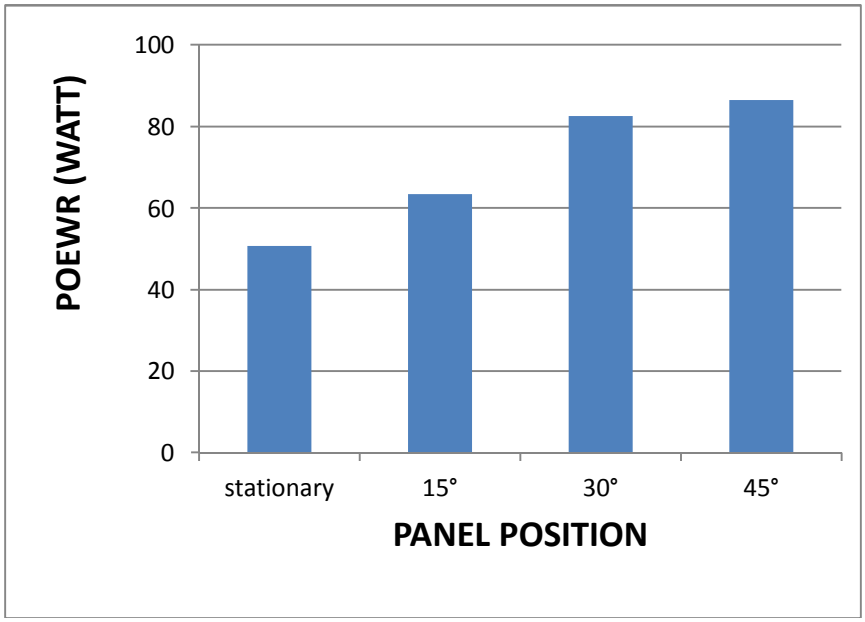

Figure 1. Panel position versus power generated

Conclusion

From the result obtained in the course of this study, the following conclusions are drawn.

- The efficiency of the solar system depends on the intensity of the sun.
- Higher current is generated when the solar panel is rotating than when it is stationary and placed at an inclined angle.
- The highest current was obtained when the solar panel was in the south and at an angle of 45°.

References

[1]. Akintola, T. A., and Alamu, O. J., (2010) "Application Potentials and Sustainability of Solar Energy in Nigeria" Pacific Journal of Science and Technology, 11(2):132-138.

[2]. Awogbemi, O., and Komolafe. C.A., (2011) "Potential for Sustainable Renewable Energy Development in Nigeria" Pacific Journal of Science and Technology 12(1): 161-169

[3]. Babatunde, E. B., (1998) "Fundamentals of Solar to Heat Transfer and Flat Plate Collectors In: Principles, Measurements and Applications of Solar and Atmospheric Radiation" An International College Lecture Series organized by the Department of Physics, University of Ilorin, Nigeria (26th October – 6th November, 1998.

[4]. Bala, E.J., Ojosu, J. O., and Umar, I. H., (2000) "Government Policies and Programmes on the Development of Solar PV Sub-sector in Nigeria" Nigeria Journal of Renewable Energy, 8(1&2):1-6

[5]. Chendo, M.A.C. (2002) "Factors Militating Against the Growth of the Solar – PV Industry in Nigeria and their Removal" Nigeria Journal of Renewable Energy, 10(1&2):151 – 158.

[6]. Jekayinfa, S. O. and Scholz, V. (2009) "Potential Availability of Energetically Usable Crop Residues in Nigeria". Energy Sources, Part A, Vol. 31: 687-697.

[7]. Kaygusaz, K and M.F.,Turker, (2002) Biomass Energy Potential in Turkey. Biomass and Bioenergy, 26:661-678.

[8]. Oladeji, J.T., (2011a) "The Effects of Some Processing Parameters on Physical and Combustion Characteristics of Corncob Briquettes An Unpublished Ph.D Thesis, Department of Mechanical Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

[9]. Oladeji, J.T., (2011b) "Agricultural and Forestry Wastes and Opportunities for their use as an Energy Source in Nigeria" An Overview. World Rural Observations 3 (4):107-112

[10]. Oladeji, J.T., (2011c) "Investigations into the Effects of Different Binding Ratios on some Densification Characteristics of Corncob Briquettes. New York Science Journal, 4(11):55-58.

[11]. Oladeji J.T. (2012) "Comparative Study of Briquetting of Few Selected Agro-Residues Commonly Found in Nigeria" Pacific Journal of Science and Technology, 13(2):80-86.

[12]. Osueke, C. O., and Ezugwu, C.A.K. (2011) "Study of Nigeria Energy Resources and Its Consumption" International Journal of Scientific & Engineering Research, Volume 2 (12):121-130.

[13]. Smil N. (2003) "Energy at the Crossroads: Global Perspectives and Uncertainties" MIT Press, pp.44

[14]. The National Academics Press (2007) "Committee on creation of Science Based industries in Developing Countries" (National Research council of the U.S National Academic and Nigerian Academic of Science) (2007) Mobilizing Science-Based Enterprises for energy, water, and Medicines in Nigeria,

[15]. Types of renewable energy, (2010) Available at http://www.learnabout energy.org/renewableenergy/renewable energy 4.htm.

5/23/2013