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DETERMINATION OF SOLAR ENERGY POTENTIAL WITHIN ZAMBUK TOWN, YAMALTU DEBA LGA, GOMBE STATE, NIGERIA

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ABSTRACT

There are two energy sources, renewable and nonrenewable energy sources. Solar energy is one of the renewable sources. This energy is generated by means of solar panels. This sources of energy can be used as an alternative to the use of gas powered power plant and even hydroelectric power. Several studies have been made in different places for potential solar energy power. In this work, the solar energy potential in Zambuk town was determined from daily 2022 temperature data obtained from National Aeronautic and Space Administration (NASA). Using some physical laws, the possible power that could be generated in that area was determined under the assumption that the efficiency of the solar panels to be 18%. It was found that this energy has the highest potential during the months of March, April and Mayand has lowest value during the month of January and December. It was recommended other data are to be used to determine the potential within the area as this will reduce the over dependence on the hydroelectric sources of energy and will reduce carbon emission to the outer space.

Keywords and phrases: *Renewable Energy, Nonrenewable Energy, Hydroelectric Power, National Aeronautic and Space Administration (NASA)*

INTRODUCTION

Solar energy (radiant light and heat from the Sun) can be harnessed with technologies such as solar power (which is used to generate electricity) and solar thermal energy (which is used for applications such as water heating).As a renewable and clean energy source, solar can be used as a replacement of fossil fuels, producing heat, creating chemical reactions and generating electricity. Solar energy technology can be built flexibly at scale and allows the energy that is collected to be stored for later use. The

amount of potential solar energy that reaches the Earth each day far exceeds the current and expected future energy requirements of the world. The question is just how to harness the potential and, in order to understand this, we need to look at how solar energy works (Gufta N. G et al.,2009). Sunlight is the largest energy source to reach the Earth but, despite this, the intensity of the energy that reaches the Earth's surface is relatively low due to the radial spreading of solar radiation as it travels from the distant sun. More of this sunlight is lost in the Earth's atmosphere and due to clouds, which between them scatter as much as 54% of the incoming light. As a result the sun light that reaches the ground is around 50% visible light and 45% infrared radiation which the rest being made up of small amounts of ultraviolet and other types electromagnetic radiation. Although much of the solar energy is lost as it travels to the surface of the Earth, this energy still equals around 200,000 times the daily total electricity generating capacity of the world. Exploiting this renewable resource can be difficult however, with collection, conversion and storage still being quite costly (Kumar S., 1994). In Nigeria, the power generated annually from hydroelectric power plants and gas fired thermal power plants is estimated to be less than 12 thousand Megawatts. This power is inadequate to provide enough electricity to even one industrious state. This has made it necessary to look for other alternatives which can fill the gap in the power sector. The use of renewable energy source will fill this gap and will reduce the carbon emission and hence reduce the global warming.

Studies about power generation in Nigeria have been made and different scientific recommendations have been given on how the power shortage bedeviling the country could be dealt with. Aliyu, 2010 in his unpublished work, studied solar energy potential within Gombe state university and he proposed how this clean and reliable source of energy can be used as a solution to the ever growing demand of power in the university campus in particular and Nigeria in general. In this work, the solar energy potential in Zambuk town will be determine from daily temperature data from National Aeronautic and Space Administration (NASA) for the year 2022 using some physical laws, the possible power that could be generated in that area will also going to be determine.

SOME PHYSICAL LAWS ASSOCIATED WITH SOLAR ENERGY POTENTIAL

Wien's displacement law:

$$\lambda max = \frac{2.879x10^{-3}}{T} \qquad (1.1)$$

Where λmax = the peak wavelength of energy, T = the temperature of the object radiating energy

Stefan-Boltzman Law:

The irradiance or radiation output of an object can be calculated using the Stefan-Boltzmann law when the temperature is known.

Stefan- Boltzmann law

$$E=I=\delta T^4 \qquad (1.2)$$

Where E = surface irradiance of the object ð = Stefan- Boltzmann constant (5.67 x 10^{-8} W/m^2k^4)

And T = Temperature of the object

The Wien's displacement and Stefan- Boltzmann laws strictly apply only to black bodies (Arinze,1986)

Solar Intensity

Mathematical expression for solar intensity (Solar Radiation)

$$I = \frac{E(4\pi R^2)}{4\pi r^2} \qquad (1.3)$$

Where I = irradiance at the surface of the outer sphere, E = irradiance at the surface of the object $4\pi R^2$ = surface area of the object, $4\pi r^2$ = surface area of the outer sphere

Also solar intensity can be calculated using

$$I(\lambda,T)=\frac{8\pi kT}{\pi} \qquad (1.4)$$

Where I = intensity of the sun k = Boltzmann constant, λ = wavelength, *T*= Temperature

Efficiency of solar panel

A solar cell's energy conversion efficiency is the percentage of power converted (from absorbed light to electrical energy) and collected, when a

solar cell is connected to an electrical circuit. This term is calculated using the ratio of the maximum power point and the input light irradiance and the surface area of the solar cell (Arinze,1986)

$$\eta=\frac{p}{EXA} \quad (1.5)$$

The equation of the efficiency can be used to calculate the power that can be obtained from a particular panel. We have

$$P= ExA x\eta \quad (1.6)$$

Where E is the irradiance of the sun, A= area of the solar panel, η= efficiency of the panel

Available community solar panels are (as of 2022) 18% efficient in average, which is a little bit greater that what it was 12 years ago.
To find the total power that can be generated in every month using these panels, the above physical laws are applied

MATERIALS AND METHODS

A daily average temperature of Zambuk town at 2m high was found from the website of National Aeronautics and Space Administration (NASA).
Equation (1.1) was used to find the maximum wavelength,
The mean monthly temperature(MMT) was obtained using the equation

$$MMT=\frac{sum\ of\ daily\ temperature}{number\ of\ days\ in\ a\ month} \quad (1.7)$$

The energy radiated per unit area per unit time was calculated from equation (1.2)

The mean power was calculated with equation (1.3) using the energy radiated per unit area per unit time. The possible power that can be generated in the area was obtained using equation (1.4) under the assumption that the efficiency of the solar panels to be 18%

RESULTS AND DISCUSION

RESULTS

MONTHLY MEAN TEMPRATURE AT 2m

Table 2.1: Average monthly temperatures in Zambuk

MONTHS	AVERAGE TEMPRATURE (c)	AVERAGE TEMPRATURE (Kelvin)
January	20.87	293.87
February	23.39	296.39
March	28.98	301.98
April	32.91	305.91
May	30.93	303.93
June	29.45	302.45
July	27.02	300.02
August	25.35	298.35
September	24.97	297.97
October	26.67	299.67
November	26.58	299.58
December	24.98	297.98

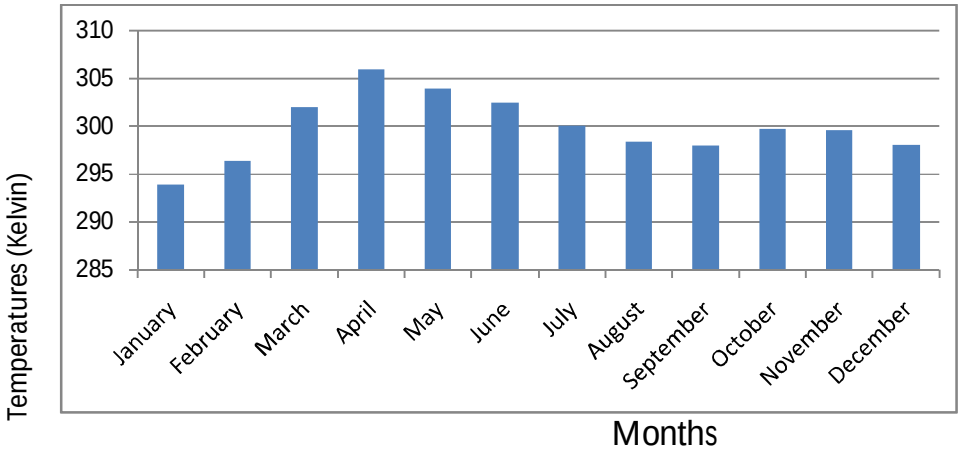

Figure 2.1: A graph of temperatures in Kelvin against months of 2022

MEAN MAXIMUN WAVELENGTH OF SOLAR RADIATION

The maximum wavelength for every month of the year was found using Wien's displacement law, equation 1.1

Table 2.2 Table of mean wavelength

NUMBER OF MONTHS	MEAN $\lambda_{max}(10^{-6}m)$
January	9.86
February	9.77
March	9.59
April	9.47
May	9.53
June	9.58
July	9.66
August	9.71
September	9.72
October	9.67
November	9.67
December	9.72

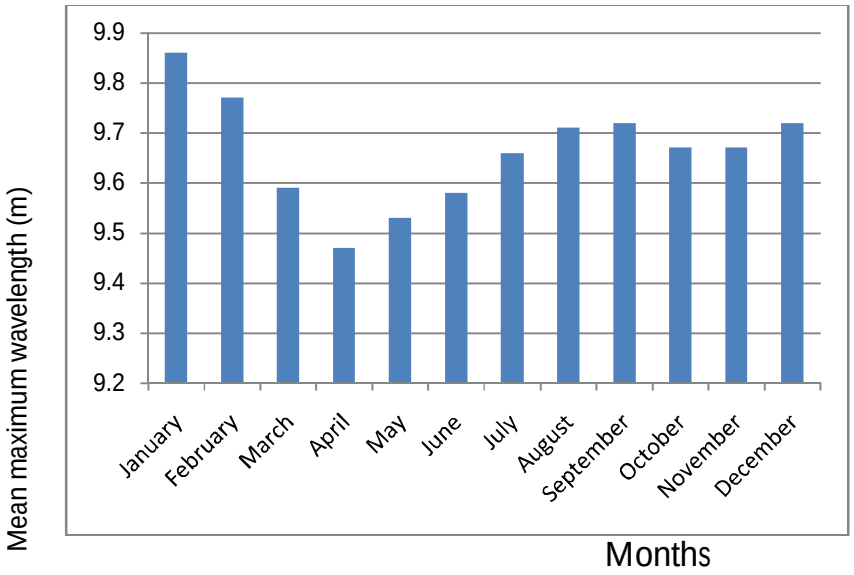

Figure 2.2: A graph of maximum wavelength in $x10^{-6}$ against the number of months of the year

MEAN POWER OBTAINED PER UNIT AREA

The mean power per unit area obtained for every month was calculated by using equation 2.22

Table 2.3: mean power generated every month

NUMBER OF MONTH	MEAN POWER (W/m^2)
January	422.87
February	437.56
March	471.52
April	496.54
May	483.81
June	474.46
July	459.39
August	449.25
September	446.96
October	457.25
November	456.70
December	447.02

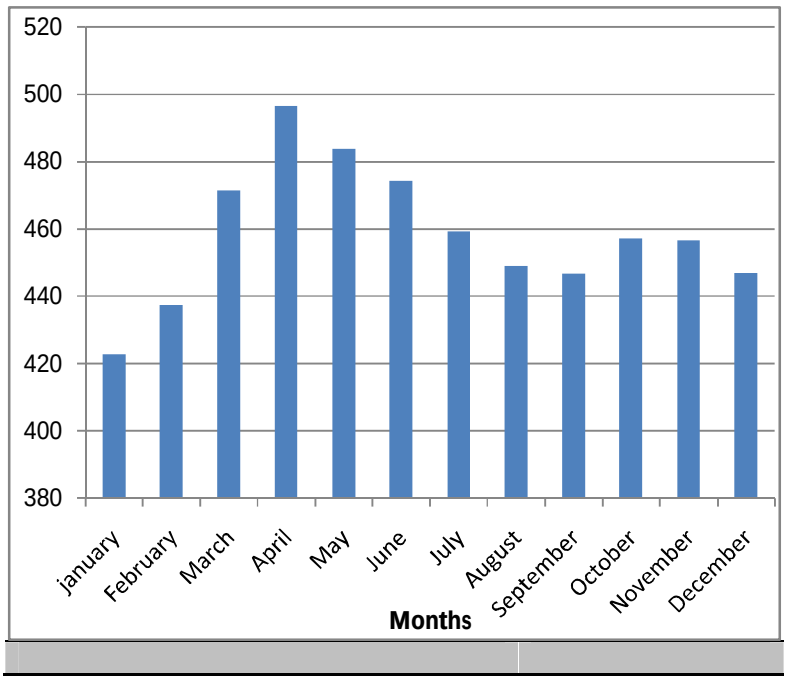

Figure 2.3: A graph of mean power per unit area against months

MEAN POTENTIAL POWER GENERATED

Table 2.4Table of mean potential power generated

NUMBER OF MONTHS	MEAN ELECTRICAL POWER (Watts)
January	76.12
February	78.76
March	84.87
April	89.38
May	87.09
June	85.40
July	82.69
August	80.87
September	80.45
October	82.31
November	82.21
December	80.46

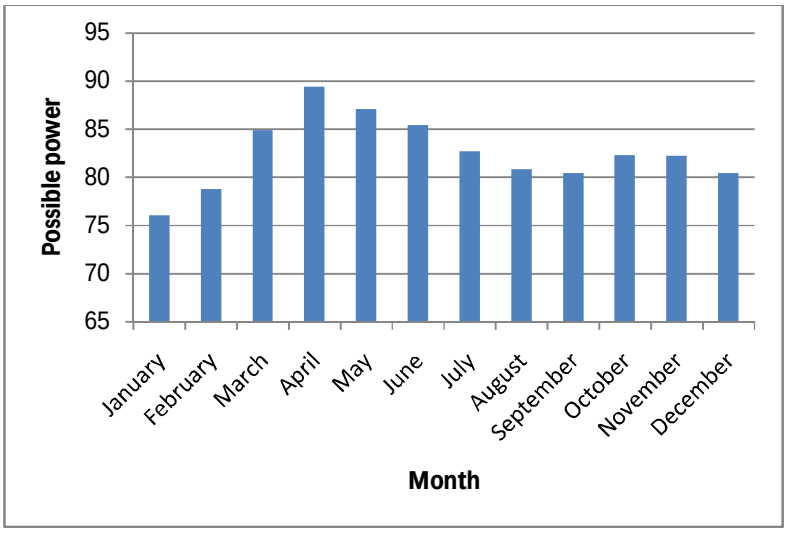

Figure 2.4A graph of Maximum possible power generated per month.

DISCUSSION

From figure 2.1 it can be seen that the temperature is high during the month of April and May followed by June. The moderate temperature appears during the month of August while it has the lowest value in January and lower in December.

Figure 2.2 presents the radiation wavelength and it was found that it is very low in April, May and June, higher value during the month of December and highest in January and February.

From figure 2.3 it was observed that the mean power generated occurs during the month of April, May followed by June, lower value in August, February and January. In Figure 2.4 the maximum possible power potential happens to be during the month of April, May and June and moderate in August, September and December with the lowest value in January and February. The results above clearly indicates the solar potential varies with time.

CONCLUSION

This work determined the solar energy potential of Zambuk and it has found that solar energy can be generated using solar panels within that area. And it was found that April has the maximum possible power generated per month.

RECOMMENDATION

Since this work used only 2022 data to determine the solar energy potential, we cannot exactly used it to generalize the potential within the area. it was recommended other data are to be used to determine the potential within the area as this will reduce the over dependence on the hydroelectric sources of energy and will reduce carbon emission to the outer space.

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