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Research Paper

Solar Power System: A Viable Renewable Energy Source For Nigeria

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ABSTRACT: Energy is a very important variable that its conservation is of paramount interest to engineers of our time. As we know, the law of conservation of energy states that energy can neither be created nor destroyed, but it can be transformed from one form to another. This helps in sustainable use and protection of natural resources. This research work on power generation from solar source is a system that assists in this energy transformation and storage to produce electricity.
Electricity is one form of energy that affects almost every sphere of life. All our electronic equipment need a source of electrical energy to function .Hence the quest for obtaining this source of energy from different means is in high demand. Originally, the source of electrical energy was predominantly hydro. But today other forms of energy are being harnessed so as to convert them to electrical energy. Solar energy is one source of energy that is harnessed today to provide electricity. Here solar energy is converted to electrical energy by solar panel made up of transducers called solar cell. These panels are placed on the top of houses or towers for the purpose of obtaining maximum incident solar energy. But since, the position of the sun with respect to solar panel is not fixed, as a result of the earth's revolution around the sun, it is important to have an automatic tracking system that will help position the panel at all till times for maximum reception. This received energy is temporarily stored in an accumulator via the battery charging circuit and is finally made available for use through the inverter circuit. An attempt to design a power system that will harness this renewable source of energy to better the lots of mankind forms the base of this research work (project).

Keywords: *Battery, Electricity, Energy, Inverter, Renewable Energy, Solar Cells, and Solar Energy.*

I. INTRODUCTION

I.1 General Description

Flywheel power, but local power generation capability is required to achieve full availability. In Power generation is a key component of a high availability power system for mankind. Information Technology systems may operate for minutes or even a few hours on battery or locations with poor power, power generation may be needed to achieve 99.99% or even 99.9% availability over the period from 1950 to 2002, in most recent year for which data are available, annual world electric power production and consumption rose from slightly less than one trillion kilowatt-hours (KWh) to 15.3 trillion KWh. A change also took place in the type of power generation. In 1950 about two-thirds of the world's electricity came from steam-generating sources and about one-third from hydroelectric sources. In 2002, thermal sources produced 64 percent of the power, but hydropower had declined to 17 percent with increased dependency on electrical power for various domestic and commercial purposes and the seemingly declining capacity of power utilities, especially in Nigeria, the need for additional backup power source is on the rise. So, there is a global need to increase energy conservation and the use of renewable energy resources. Renewable alternatives such as water power (using the energy of moving water such as rivers), solar energy (using energy from the sun), wind energy (using the energy of wind or air currents) or finally using thermal energy source. The project will therefore among other things enumerate how to harness the energy from these sources but precisely "the sun" forsome reasons that we will explore later.

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I.2 Overview of the research

Solar energy is a renewable energy resource and is converted to electrical energy in two ways thus using a photovoltaic material which generates an electrical potential when exposed to light or using a thermal process which uses the energy from the sun to heat a working fluid in an electricity generating cycle. The former will be dealt with in this work. It is a known fact that energy from the sun is quantized in photon; this photon in sunlight hit solar panel and is absorbed by semi conducting materials such as silicon. Electrons (negatively charged) are knocked loose from their atoms, allowing them to flow through the material to produce electricity. The complementary positive charges that are also created (like bubbles) are called holes and flow in the direction opposite of the electrons in a silicon panel. By this process the photovoltaic cell converts the energy into a usable amount of direct current (DC) electricity. Since this energy is required for immediate and post use, it is temporarily stored in an accumulator (battery) from where it is fed into an inverter circuit which turns the DC electricity into 220-240volt AC (Alternating current) needed in homes to drive some electronic gadgets like computers, televisions, CDs etc. The design objective of this project is to come up with a prototype of a system that will do this transformation. The diagram below shows the block diagram of the system components [1][2][3]

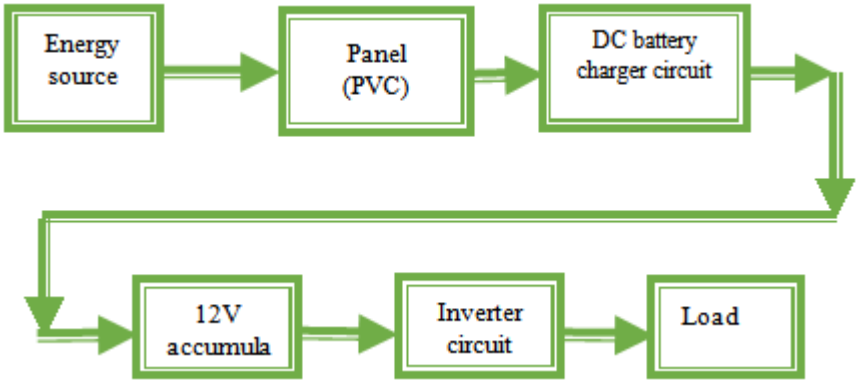

Figure 1: Project Block Diagram

I.3 Advantages of Solar Power Generation over National Grid

In the modern world there is hardly a house, a street, a business or a transport facility that does not make use of electricity. Although electricity is often seen as a panacea for all environmental ills, a lot depends on how the electricity is generated. The advantages of solar power over the national grid as a means of creating energy are obvious. They are as follows:

a) **Solar energy is renewable:** Although we cannot utilize the power of the sun at night or on stormy, cloudy days, etc., we can count on the sun being there the next day, ready to give us more energy and light. As long as we have the sun, we can have solar energy (and on the day that we no longer have the sun, you can believe that we will no longer have ourselves, either). On the other hand, the national grid, which uses oil, is not renewable. Once it is gone, it is gone. Yes, we may find another source to tap, but that source may run out, as well.

b) **Usage in remote areas:**Solar power has long been used in situations where electrical power from the national grid is unavailable, such as in remote area power generation. Far more exciting, in many ways, is the use of solar power in rural electrification efforts across the globe. According to the Solar Electric Light Fund (SELF) two billion people are currently living without access to electricity, most of who rely on kerosene to light the night. Even if it were possible for these people to pay the enormous sums necessary for grid extension, two billion more electricity consumers would have unimaginable effects on global fuel prices, and would exacerbate the environmental crisis disastrously. One simple, sustainable solution is being explored by many organizations all over the world and this is solar power. For the national grid, running of electrical wires over a long distance to remote areas and also the installation of power plants are difficult. One of the most important and obvious benefits of solar power has always been that it can provide electricity where the national grid cannot reach.

c) **Easy to maintain:** Solar cells require very little maintenance (they have no moving parts that will need to be fixed), they are very easy to keep running and they last a long time. Solar power (solar cells) is durable, that it's not unreasonable to leave an untended panel in the middle of the desert and expect it to operate for decades. Solar can operate long-term with absolutely NO infrastructure – no roads, no technicians, no tools, and of course no grid. On the other hand, utility companies need to keep diagnostic equipment running at various

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points along long-distance transmission lines and technicians and engineers to monitor the power plants and transmission lines. This ease of maintenance makes solar power generation perfect for many applications.

d) **It is pollution free:** Solar energy is non-polluting and abundant. The abundance of the sun means that very little to no fossil fuels will be burnt producing energy. The lack of harmful emissions in sun power production means that there is no harmful geographic footprint left by the user. Electricity generated by fossil fuels will still create carbon dioxide pollution and other greenhouse gases and carcinogens into the air. Solar cells are totally silent. They can extract energy from the sun without making a peep. Solar powered lights and other solar powered products are also very easy to install. You do not even need to worry about wires.

II. LITERATURE REVIEW

II.1 How Power is being Generated using Different Kinds of Energy Sources

There are so many ways to produce electricity – electron can flow between certain different materials, provide a current, as in a common battery (such as the reliable and portable chemical battery which runs down easily). To provide the large amount of steady power demanded by the modern societies, alternate source of power generation is needed which includes hydro, thermal, solar, and wind respectively. Accordingly, all these source of power generation involves a generator except solar.[4] Therefore for proper analysis, generator have two important parts: the rotor (which rotates) and the stator (which remains stationary).Generator use the principle of electromagnetic induction, which exploits the relation between magnetism and electricity.[5] In large AC generation, an outer shell with powerful magnet rotates around a stationary "armature" which is round with heavy wire. It is importance to recognize that electricity is not mined or harvested, it must be manufactured at time of demand, electricity is a form of energy, but not an energy source. Different generating plant harness different energy sources to make electric power.[4]

II.2 Renewable and Non-renewable Energy Sources

Energy sources can be divided into renewable and non-renewable. Renewable energy source is a form of energy that is continually replenished as quickly as it is extracted and used up. Renewable energy will therefore never run out. Such as wind energy, solar energy, hydro energy generation etc. Non-renewable is a form of energy that is not continually replenished as quickly as it is extracted and used up. Hence they will run out, for example, natural gas, coal, geothermal, nuclear fission

Explanation on Various Sources of Power Generation

a) **Thermal Power Generation:**This power generation uses energy from heat to make electricity. Water is heated in a boiler until it becomes high-temperature steam. This steam is then channelled through a turbine, which has many fan blades attached to a shaft. As the steam moves the steam moves over the blades, it causes the shaft to spin. The components of the turbine convert mechanical energy to electrical energy, hence we have electricity. The diagram of the interactivity of these components in thermal generation is shown here below:

b) **Hydro-Power Generation:**Like most other renewable energy sources, hydro-power is indirectly produced by the Sun when water evaporates from the Earth's surface and is deposited as rain on the landmasses and runs back down to the sea via rivers. The potential energy, or energy due to height, can be extracted by flowing the water through turbines as it moves from a higher level to a lower one. Hydro is already a major contributor to world energy supplies and the technology required to convert this energy into motive power or electricity is very mature. Hydroelectricity has been generated over the past hundred years at prices that can directly compete with oil, coal, and nuclear power stations. About one fifth of the world's annual electrical demand is met by hydroelectricity and 30 or more countries rely on it as their primary source of electricity. Many of the most suitable sites for hydro schemes have already been exploited, usually by building enormous dams, several of which constitute the largest structures in the world. Many of these schemes have resulted in the displacement of tens of thousands of people to higher ground as large valleys are flooded. This displacement has proved to be a high price to pay and there is growing concern for the safety of many tens of thousands of people who now live under the shadow of these huge dams and who would most likely receive no warning if the dam walls were to fail. There is currently about 630 GW of installed hydroelectric generating capacity and the annual world production is about 2,200 TWh. This represents about a 40 per cent load factor, which means that only 40 per cent of the theoretical maximum generating capacity is realized. The figures suggest that only a small percentage of the estimated total theoretical resource of 50,000 TWh a year is being captured, but this is because of many factors, including the immovable nature of the resource, the large scale of environmental impact of these projects, and the very high capital outlay cost. The technically accessible resource is probably only 10 to 20 TWh (according to UN data from 1992)[6][7]

c) **Wind Power Generation:**Wind – air in motion. In meteorology the term is usually applied to the natural horizontal motion of the atmosphere; motion in a vertical, or nearly vertical, direction is called a current.

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Winds are produced by differences in atmospheric pressure, which are primarily attributable to differences in temperature. Variations in the distribution of pressure and temperature are caused largely by unequal distribution of heat from the Sun, together with differences in the thermal properties of land and ocean surfaces. When the temperatures of adjacent regions become unequal, the warmer air tends to rise and flow over the colder, heavier air. Winds initiated in this way are usually greatly modified by the Earth's rotation.[8][9]
Wind Anemometer – The anemometer is a device for measuring wind speed. Designs of anemometers differ, but all have cups (three or four) that revolve on a spindle. Regardless of the direction of the wind, the faster it blows the faster the cups rotate. Wind speed is measured by the number of revolutions of the cups in any given time. Often the revolving cups drive an electric generator connected to a meter that calibrates the wind speed.
Winds may be classified into four major types: the prevailing winds, the seasonal winds, the local winds, and the cyclonic.

II.3 Comparism of the Four Power Generation Based on theAvailability of the Renewable Resources.

As in most of West Africa, Nigeria's climate is characterized by strong latitudinal zones, becoming progressively drier as one moves north from the coast. Rainfall is the key climatic variable, and there is a marked alternation of wet and dry seasons in most areas. Two air masses control rainfall – moist northward-moving maritime air coming from the Atlantic Ocean and dry continental air coming south from the African landmass. Topographic relief plays a significant role in local climate only around the Jos Plateau and along the eastern border highlands.

In the coastal and southeastern parts of Nigeria, the rainy season usually begins in February or March as moist Atlantic air, known as the southwest monsoon, invades the country. The beginning of the rains is usually marked by the incidence of high winds and heavy but scattered squalls. The scattered quality of this storm rainfall is especially noticeable in the north in dry years, when rain may be abundant in some small areas while other contiguous places are completely dry. By April or early May in most years, the rainy season is under way throughout most of the area south of the Niger and Benue river valleys. Farther north, it is usually June or July before the rains really commence. The peak of the rainy season occurs through most of northern Nigeria in August, when air from the Atlantic covers the entire country. In southern regions, this period marks the August dip in precipitation. Although rarely completely dry, this dip in rainfall, which is especially marked in the southwest, can be useful agriculturally, because it allows a brief dry period for grain harvesting.

From September through November, the northeast trade winds generally bring a season of clear skies, moderate temperatures, and lower humidity for most of the country. From December through February, however, the northeast trade winds blow strongly and often bring with them a load of fine dust from the Sahara. These dust-laden winds, known locally as the harmattan, often appear as a dense fog and cover everything with a layer of fine particles. The harmattan is more common in the north but affects the entire country except for a narrow strip along the southwest coast. An occasional strong harmattan, however, can sweep as far south as Lagos, providing relief from high humidity in the capital and pushing clouds of dust out to sea.

Given this climatologically cycle and the size of the country, there is a considerable range in total annual rainfall across Nigeria, both from south to north and, in some regions, from east to west. The greatest total precipitation is generally in the southeast, along the coast around Bonny (south of Port Harcourt) and east of Calabar, where means annual rainfall is more than 4,000 millimeters. Most of the rest of the southeast receives between 2,000 and 3,000 millimeters of rain per year, and the southwest (lying farther north) receives lower total rainfall, generally between 1,250 and 2,500 millimeters per year. Mean annual precipitation at Lagos is about 1,900 millimeters; at Ibadan, only about 140 kilometers north of Lagos, mean annual rainfall drops to around 1,250 millimeters. Moving north from Ibadan, mean annual rainfall in the west is in the range of 1,200 to 1,300 millimeters.

North of Kaduna, through the northern Guinea savanna and then the Sudan savanna zones, the total rainfall and the length of the rainy season decline steadily. The Guinea savanna starts in the middle belt, or southern part of northern Nigeria.[10] It is distinguished from the Sudan savanna because it has more trees whereas the Sudan few trees. Rainy seasons decline correspondingly in length as one moves north, with Kano having an average rainy period of 120 to 130 days, and Katsina and Sokoto having rainy seasons 10 to 20 days shorter. Average annual rainfall in the north is in the range of 500 to 750 millimeters.

The regularity of drought periods has been among the most notable aspects of Nigerian climate in recent years, particularly in the drier regions in the north. Experts regard the twentieth century as having been among the driest periods of the last several centuries; the well-publicized droughts of the 1970s and 1980s were only the latest of several significant such episodes to affect West Africa in this century. At least two of these droughts have severely affected large areas of northern Nigeria and the Sahel region farther north. These drought periods are indications of the great variability of climate across tropical Africa, the most serious effects

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of which are usually felt at the drier margins of agricultural zones or in the regions occupied primarily by pastoral groups.

Temperatures throughout Nigeria are generally high; diurnal variations are more pronounced than seasonal ones. Highest temperatures occur during the dry season; rains moderate afternoon highs during the wet season. Average highs and lows for Lagos are 31° C and 23° C in January and 28° C and 23° C in June. Although average temperatures vary little from coastal to inland areas, inland areas, especially in the northeast, have greater extremes. There, temperatures reach as high as 44° C before the onset of the rains or drop as low as 6° C during an intrusion of cool air from the north from December to February.

II.4 Solar and Wind Power Source Preferred over Other Sources

It is undoubtedly true that other sources of power generation like thermal, tidal, and hydro, nuclear energy etc. exists but in this research work we will base the illustrations and data analysis on the above stated two, because of the following reasons enumerated below:

a) **Variable Nature of Power Output:** Hydro power as we know is highly dependent on the water flow current as well as its height. But it was observed that the height of some rivers reduce appreciably during dry season, thereby affecting the power output. Again tidal power, sometimes called *tidal energy*, is a form of hydropower that exploits the rise and fall in sea levels due to the tides, or the movement of water caused by the tidal flow. Because the tidal forces are caused by interaction between the gravity of the Earth, Moon and Sun. Tidal power schemes do not produce energy all day. A conventional design, in any mode of operation, would produce power for 6 to 12 hours in every 24 and will not produce power at other times. As the tidal cycle is based on the rotation of the Earth with respect to the moon (24.8 hours), and the demand for electricity is based on the period of rotation of the earth (24 hours), the energy production cycle will not always be in phase with the demand cycle. This is unlike the power produced from solar and wind which is fairly constant only that solar varies with day and night while wind varies with speed and direction. These two defects can be accommodated by integrating an accumulator in the system. This ensures constant power output.

b) **Pollution:** Like many developing countries in Africa, Nigeria has experienced a significant increase in its electricity needs as it is developing. Since coal is one of the sources of its energy for power generation. Its combustion process has led to an increase in pollution and environmental destruction. The air in cities and communes is seriously polluted by dust from mining works. Every year, mines discharge of wastewater that carries large amounts of pollutants are evacuated into rivers and the sea. This causes a wide variety of environmental problems. Other problems caused by the mine industry include solid waste, radioactive gas emissions, noise pollution and forest destruction. All in the attempt to produce coal which is the primary material for thermal energy generation process. The economic implications of health problems associated with mining (including injuries, lost productivity costs and mortalities) and looked at how much is spent on air, water and noise treatment to clean up the industry's pollution. The researchers also investigated the impact of the mining industry on tourism and recreation and what effect it had on agriculture, forest production, fisheries and infrastructure. The contrast between a great alternative energy system and one that is used on only home must be observed. Nuclear power would not be used to power a home because of the possible contamination and nuclear infiltration of radioactive isotopes that would be dangerous to live around. Having seen this reason, several young prospective Engineers have decided to improve on wind and solar since they are pollution free.

c) **Resource Availability:** Since the sun is the ultimate source of solar energy and the wind, for wind energy, so for each passing day, there is fairly available sun or wind that will energize/drive the transducer in the circuit. With these in place, there is no shortage of solar-derived energy on Earth. Indeed the storages and flows of energy on the planet are very large relative to human needs. The amount of solar energy intercepted by the Earth every minute is greater than the amount of energy the world uses in fossil fuels each year only that very little of it is harnessed for power generation. This is unlike nuclear energy which depends on the availability of radioactive material, hydro energy which depends on the availability of high current rivers etc. The energy in the winds that blow across the United States each year for instance could produce more than 16 billion GJ of electricity—more than one and one-half times the electricity consumed in the United States in 2000. So wind and solar are in continuous supply as compared to others.

III. RESEARCH METHODOLOGY

III.1 Statistical data presentation and Analysis for wind speed and sunshine hour

In order to appropriately carry out an excellent implementation of what alternative power generation mean, it will be preferable to use Enugu State (Nsukka) as a case study. The need arises for the group (project group) to go out and gather facts on the factors that affect the generation of power using either Wind turbine or

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Solar panel, since these are the two that were Stream-line during our literature review with regards to the resources available at our site location.

The two major factors that are required in this case aside others that will be looked into at the end of this chapter briefly, are the wind speed and sunshine hour. And for better analysis we required to get records of these two data and tabulated. These records are gotten and recorded for a period of one year from our own Energy Research Centre (UNN) and Sir Francis Ibiam International Airport meteorological department since they are both based in Enugu State which is our case study. Table (1) and (3) shows the data for Wind speed and Sunshine hour respectively.

Table 1: A Table showing Wind Speed Data collected between January and March, 2006.

Summary 7 meterological Observation at Enugu for January 2006

					Wind no of Observation								
	Beaufort Force 8	6 - 7	4 - 5	1 - 3	Calm	NE	E	SE	S	SW	W	NW	N
HOUR	Velocity in Knots 34 or more	22 - 23	11 -21	1 - 10	0	25 - 65	70 - 110	115 - 155	160 - 200	205 - 245	250 - 290	295 - 335	310 - 320
0	3		7	9	15	1		4	5	5	1		
3	3			11	20			2	5	4			
6	6			9	22	2	1			1	3	2	
9	9		4	18	9	1	1	1	1	2	13	3	
12	12		1	26	4	3	1		4	6	9	4	
15	15		2	22	7		2	2	8	5	4	3	
18	18		1	22	8				2	14	7		
21	21	1	1	20	9			1	3	6	12		
TOTAL		1	16	137	94	7	5	4	24	44	57	13	

Summary 7 meterological Observation at Enugu for February 2006

					Wind no of Observation								
	Beaufort Force 8	6 - 7	4 - 5	1 - 3	Calm	NE	E	SE	S	SW	W	NW	N
HOUR	Velocity in Knots 34 or more	22 - 23	11 -21	1 - 10	0	25 - 65	70 - 110	115 - 155	160 - 200	205 - 245	250 - 290	295 - 335	310 - 320
0				18	10				2	9	7		
3			1	17	10					9	7	2	
6				11	17				2	7	2		
9			5	19	14		1		2	9	8	4	
12			5	20	3	1		1	5	3	11	4	
15			2	24	2			3	5	9	5	3	1
18			1	24	3	1		1	6	9	6	2	
21		1	1	18	8		1		3	13	3		
TOTAL		1	15	151	67	2	2	5	25	68	49	15	1

Summary 7 meterological Observation at Enugu for March 2006

					Wind no of Observation								
	Beaufort Force 8	6 - 7	4 - 5	1 - 3	Calm	NE	E	SE	S	SW	W	NW	N
HOUR	Velocity in Knots 34 or more	22 - 23	11 -21	1 - 10	0	25 - 65	70 - 110	115 - 155	160 - 200	205 - 245	250 - 290	295 - 335	310 - 320
0			6	8	15	1			3	4	5	1	
3				12	21				2	6	4		
6			1	8	22	1	1			1	3	2	
9			4	19	8	2		1	2	2	13	2	
12			1	26	4	2	2		4	6	8	5	
15			2	22	7	1	2	2	8	5	4	3	
18			1	22	8				2	13	7		
21		1	1	20	9			1	3	7	13		
TOTAL		1	16	137	94	7	5	4	24	44	57	13	

The data collected and the recorded are done in Knot, which will be later converted to meter per second (m/s) to enable us do the necessary calculation to determine the possibility of using a windmill using the wind speed average value.As could be seen, the tabulated data was for the month of January to March of 2006, being the period of much wind, which hold to the fact that this period of the year have much increase in temperature, which causes the pressure difference that generate the wind due to conventional flow of wind on the Earth surface. Still on this conventional moving due to pressure, it was realized that this pressure is much more in area where there is River or Ocean due to large difference in temperature.

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III.1.1 Analysis of the Tabulated Data (Wind)

The analysis is done with the help of a graph by first determining the average value of the wind speed and using table (2) for the average values to plot a graph as shown below.

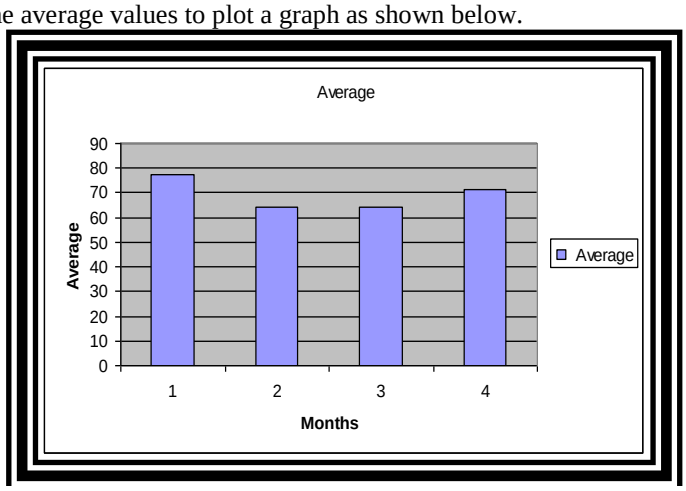

Figure 2: Graphical Analysis of Average Wind Speed for a Quarter Year

Table 2: Sunshine Hours for Quarter Year (January to April, 2006)

Sunshine hours for Quarter year (January to April)				
Days	**January**	**Febuary**	**March**	**April**
1	6.4	6	6.7	6.7
2	7	6.5	5.2	0
3	6.5	7.2	4.7	7.2
4	5.6	6.9	7.3	8.9
5	7.4	8.4	9.1	8.9
6	5.7	7.5	7.9	3.7
7	8.3	7.7	8.4	9.1
8	6.5	6.8	9.1	0
9	2.5	8	9.3	5.8
10	3.9	8.4	9.4	8.9
11	8	6.6	9.1	0
12	3.4	8	6.3	9.6
13	8.6	8.4	6.4	4.9
14	7.9	6.6	8.5	0.9
15	7.5	6.9	9.1	8.6
16	7.6	8.2	0.9	0
17	8.1	8.2	7.7	0
18	8.4	6.3	7.2	3.5
19	7.3	7.6	8.5	5.8
20	3.6	6.3	9.1	7.6
21	5.2	7.6	0.9	0.9
22	6.1	6.3	7.2	6.9
23	5.5	5.4	9.1	2.9
24	4.6	2.1	7.6	2.9
25	6.9	6.2	9.1	7.6
26	3.8	8.9	7.7	2.1
27	7	8.3	7.2	9.9
28	6.4	5.6	6.6	8.4
29	6.7	5.5	6	7.3
30	5.8	3.1	3.6	9.3
31		8.5		0.3
TOTAL	188.2	214	214.9	158.6
Average	6.27	6.9	7.16	5.12

The table above shows the records of the sunshine hour for the months of January to April which is a quarter of a year. This period of the year is considered to be the most temperate period of the year, when we are supposes to accumulate maximumphotons use the solar panel. And since the by inspection the values record is not stable we have to use the average of all the data recorded to determine the size of the panel in square meter and how many of these would give the required power to be generated. For proper calculation for these values after requires for the manufacturer of the panel, with the required specification.

III.1.2 Analysis of the Sunshine Tabulated Data

The analysis was carried out just the same way as that of the Wind speed using the average values of the different month for a quarter year to plot the graph as shown below

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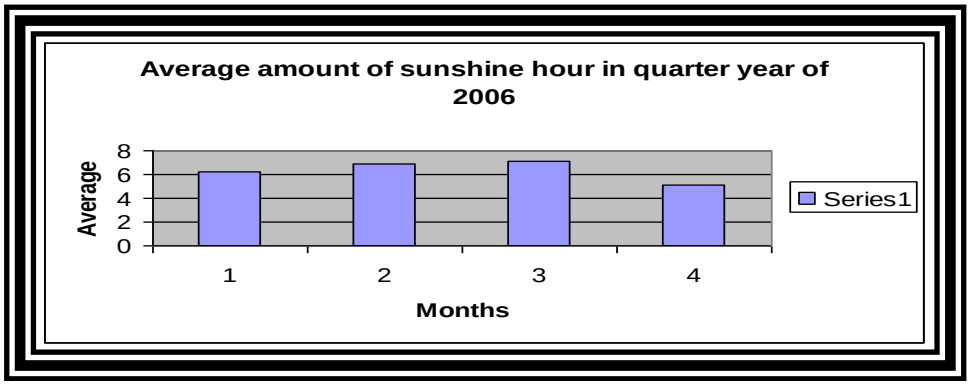

Figure 3: A Simple Bar Chart Showing the Average amount of Sunshine hour per month for the first quarter of the year 2006

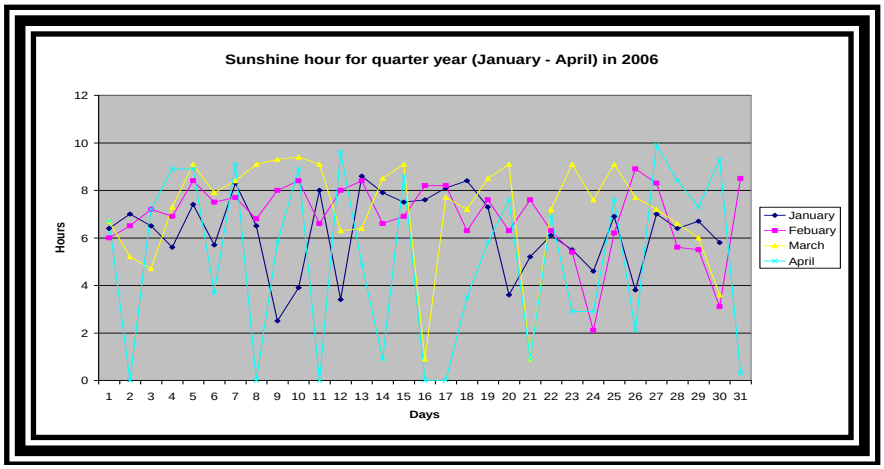

Figure 4: A graph showing the Sunshine Hour for the first Quarter of the year 2006

III.2 Consequences of the Analysis

The consequences of our analysis made it vividly clear that the average wind speed was not enough for the available wind turbine blade to generate the required power needed, which would be seen when we go ahead to do the calculation necessary for that particular blade.

III.2.1 Sitting a wind turbine

To find the site that best suits our turbine, we must consider the space around our tower. The guyedtower kits will have to tilt up into position, and will therefore have to tilt down to allow for maintenance. In practical terms, we should leave a space around our tower base equal or greater than 1.5 times the tower height. For a 7.5m tower kit, this would represent a space of 7.5 x 1.5 = 11.25m around its base. Clearly it is important to create enough space to allow the tower to tilt down without any risk to other buildings or people.
The ideal site for our tower will be on an elevated piece of land, free from trees and buildings, and in an area which satisfied the safe zone mentioned above

III.2.2 Blade

For high-speed propeller-type wind machine which are the readily available kind of windmill, the horizontal-axis wind turbine that are used today for power generation do not operate on the thrust force. It depend mainly on the aerodynamic force that develop when wind flow around the blade of aero-foil design. How this works is that the wind stream at the top of the aero-foil has to traverse a longer path than that at the bottom, leading to a difference in velocity (Bernoulli's Principle), from which a lift force result. There is of course another force that tries to push the aero-foil back in the direction of the Wind. This called the drag force. The aggregate force on the aero-foil is then determined by the resultant of these two force, knowing how this blade gets its resultant force that get it rotating, the next thing we are required to do is using our average values to calculate the energy produced by using a standard formula. Other values for this calculation are gotten after making a requisition from a manufacture based on cost.

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III.2.3 Calculation

The formula used for this calculation is

Electric power from Windmill = (0.0049) X (Average wind speed)^3 X (Swept Area) X (Efficiency)

Equation 1: Electric Power from Windmill

III.2.4 Calculations to be done later

Average wind speed is used to predict duration at speed, which gives statistical distribution.

The blade begins to feather at Wind speed above 30mph, carrying generated power to remain practicallyconstant at feathered wind speed.

For a windmill that sweep 300feet^2 with 10mph average wind speed the power generated equals 588W

Maximum generated power (limited to 30mph level) = 16kw from each Blade

Equation 2: Maximum Generated Power

Also the need for the Wind energy developed in KW is needed for us to be able to ascertain if the Siteor location is okay for installation of the windmill. The formula that will help us carrying out this calculation using the amount of electricity produce is given thus:

Electricity produce = B * 0.3 * 8760

Equation 3: Electricity Produce

Where B = rated capacity of the wind energy developed in KW

III.2.5 Solar panel

A given photovoltaic system will operate at a given geographic location, with the detail characterization of the solar resource. Enugu State being our location, when viewed from the world map is at the Equatorial region, meaning photons from the sun get to us half the whole day. And at Solar noon, we approximately receive energy (photons) of 1000w/m^2. Knowing these facts, the following information was necessary in order to generate our required amount of power:

- The Earth's source of solar radiation at Enugu: This has been fully represented by the Statistical record obtained from the Energy Research Centre and the Meteorological Department of Enugu Airport.
- The power rating per solar panel: The information was gotten from the panel manufacturers by inquiries.
- The photons that will generate maximum performance of the panel: This is known from both the first and Second consideration in order to know if this solar panel is best for implementation.
- The amount of space required to mount the panels that will produce the power needed: Size needed for a system. As the earth becomes more dense, people must judge the value of great alternative energy systems that use up large portions of the earth. The organization must also be carefully laid out to ensure maximum utilization of space, and great energy efficiency.
- The position and tilt angel of the solar panel

IV. CONCLUSION

IV.1 Alternative Energy Systems Comparison

Several major differences between wind power, water power, nuclear power, and solar power systems exist. The organization of a system for nuclear or water power may constitute only one or two turbines and one or two plants. Power lines go out directly from the power plant. A water power plant is usually a compound of several buildings that are all close together, not taking up a great amount of land.

In large scale wind power or solar power plants, many arrays of solar cells exist, and many wind towers are built. This means a great amount of wires must extend to route all of the generated power to one base that is connected to the electrical grid. A super extended wind farm or solar power farm means that a great amount of land space is taken and rendered useless for anything other than energy generation.

IV.2 Solar and Wind Power Source Preferred Over Other Sources

It is undoubtedly true that other sources of power generation like thermal, tidal, and hydro, nuclear energy etc. exists but in this research work, we based the illustrations and data analysis on the above stated two, because of the following reasons enumerated below:

a) **Variable nature of power output:**Hydro power as we know is highly dependent on the water flow current as well as its height. But it was observed that the height of some rivers reduce appreciably during dry season, thereby affecting the power output. Again tidal power, sometimes called *tidal energy*, is a form of hydropower that exploits the rise and fall in sea levels due to the tides, or the movement of water caused by the tidal flow. Because the tidal forces are caused by interaction between the gravity of the Earth, Moon and Sun. Tidal power schemes do not produce energy all day. A conventional design, in any mode of operation, would

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produce power for 6 to 12 hours in every 24 and will not produce power at other times. As the tidal cycle is based on the rotation of the Earth with respect to the moon (24.8 hours), and the demand for electricity is based on the period of rotation of the earth (24 hours), the energy production cycle will not always be in phase with the demand cycle. This is unlike the power produced from solar and wind which is fairly constant only that solar varies with day and night while wind varies with speed and direction. These two defects can be accommodated by integrating an accumulator in the system. This ensures constant power output

b) **Pollution:**Like many developing countries in Africa, Nigeria has experienced a significant increase in its electricity needs as it is developing. Since coal is one of the sources of its energy for power generation. Its combustion process has led to an increase in pollution and environmental destruction. The air in cities and communes is seriously polluted by dust from mining works. Every year, mines discharge of wastewater that carries large amounts of pollutants are evacuated into rivers and the sea. This causes a wide variety of environmental problems. Other problems caused by the mine industry include solid waste, radioactive gas emissions, noise pollution and forest destruction. All in the attempt to produce coal which is the primary material for thermal energy generation process. The economic implications of health problems associated with mining (including injuries, lost productivity costs and mortalities) and looked at how much is spent on air, water and noise treatment to clean up the industry's pollution. The researchers also investigated the impact of the mining industry on tourism and recreation and what effect it had on agriculture, forest production, fisheries and infrastructure. The contrast between a great alternative energy system and one that is used on only home must be observed. Nuclear power would not be used to power a home because of the possible contamination and nuclear infiltration of radioactive isotopes that would be dangerous to live around. Having seen this reason, young prospective Engineers have decided to improve on wind and solar since they are pollution free.

c) **Resource Availability:**Since the sun is the ultimate source of solar energy and the wind same for wind energy, so for each passing day, there is fairly available sun or wind that will energize/drive the transducer in the circuit. With these in place, there is no shortage of solar-derived energy on Earth. Indeed the storages and flows of energy on the planet are very large relative to human needs. The amount of solar energy intercepted by the Earth every minute is greater than the amount of energy the world uses in fossil fuels each year only that very little of it is harnessed for power generation. This is unlike nuclear energy which depends on the availability of radioactive material, hydro energy which depends on the availability of high current rivers etc. The energy in the winds that blow across the United States each year for instance could produce more than 16 billion GJ of electricity—more than one and one-half times the electricity consumed in the United States in 2000. So wind and solar are in continuous supply as compared to others.

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