A SURVEY ON THE STATUS OF SOLAR ENERGY UTILIZATION WITHIN THE TERTIARY INSTITUTIONS IN CALABAR

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ABSTRACT-- An experimental survey of the status of solar energy exploitation in the various tertiary institutions in Calabar is considered. A 13-item questionnaire was constructed from four research questions. A null hypotheses was formulated to determine if there is any significant shift from the conventional power sources (public power sources) to solar energy sources. The hypothesis was tested and analysedusing the Chi-square statistical method. The results show that the critical value of the strongly agree option was 41.34<42.28 with a p-value of 4.08%.The critical value of the agree option was 41.34>11.53 with a p-value of 99.74% and for the disagree option the critical value was 41.34<45.76 with a p-value of 1.85%.The analysis demonstrated only the p-value of 99.74% which established the real time position of the solar energy trend in the institutions as there is little significant shift to solar energy exploration. The study also identified the assessment rate to be at the infancy-stage due to dishonesty, unawareness, illiteracy, high cost of solar panels and its accessories, panel installation and cost of maintenance.

1 INTRODUCTION

Renewable energy is energy collected on a daily basis from sources (sunlight, wind, rain, tides, waves and geothermal heat) which are naturally abundant in nature without human effort. "[1], [2]" identified renewable energy sources are constantly replenished without any known depletion all year round. "[3]" discussed the globalization of renewable energy and its general acceptability and supportive effect on climate change.

Despite the abundance of energy resources in the world, Nigeria is yet to realize its renewable energy potential as indicated by the records of supply of electrical power across many states. At present just about 3000 megawatts electrical power is generated in the country, which is grossly inadequate even for domestic consumption. To remedy this deficiency a survey of solar energy investigation in Calabar, Cross River State of Nigeria is conducted in order to evaluate the possible benefits to the populace.

1.1 Energy Generation and Assessment

Hydro-energy

Hydro energy comes from flowing water. The country is endowed with large rivers and natural water falls, "[4]". The river Niger and Benue with several tributaries constitute the rivers which offers the greatest potential for hydropower development. The hydro station does not use hydrocarbons to generate power, unlike coal or gas plants. "[5], [6]", hydropower systems utilise the potential energy difference between levels of water in reservoirs. Nigeria's energy base, which accounts for about 29% of the national energy supply is hydropower from three major dams: Kainji, Shiroro and Ikom. The largest of these dams has a hydropower capacity of 11,500MW and the smallest has a hydropower capacity of 3,500MW. Only 1,972MW of the large hydropower capacity has been utilised while 64.2MW has been exploited from the small hydro power system."[7]".

Biomass

The plant derived organic matter available on a renewable basis includes: dedicated energy crops and trees, agricultural food and feed crops, crop wastes and residues, aquatic plants and animal wastes, municipal waste, wood, forage grasses and shrubs, and other materials that are referred to as Biomass "[8]".Biomass uses the energy from plants and waste materials to generate electricity. "[9]" provides an historical overview of how humans have harnessed biomass -derived energy through the burning of wood to make fire. Biomass is all biologically produced matter, based on carbon, hydrogen and oxygen. The estimated biomass production in the world is 104.9 pentagrams (104.9×10^{15} g- about 105 billion metric tons) of carbon per year, about half in the ocean and half on land. Biomass can be converted into other useable forms of energy like methane gas or transportation fuels like ethanol and biodiesel. Rotting garbage,

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agricultural and human waste, all release methane gas, also called landfill gas or biogas. "[10]" estimated that the national biomass energy (biogas) to be about 8 x 10^2 MWJ. More research is needed in this area to determine the percentage of biomass utilization in the country, though most populace especially the low income earners, the less privileged and rural dwellers derive their energy sources from biomass.

WIND ENERGY

Wind is a natural phenomenon related to the movement of air masses caused primarily by the differential solar heating of the Earth's surface. "[11]"the strength and direction of the wind is affected by seasonal variations in the energy received from the sun. Wind turbines transform wind energy into rotary mechanical energy which is used to drive electrical generators. Wind energy applications also include water pumping, milling of grains etc.

Nigeria is located within a low to moderate wind energy zone."[12]" identified four different wind zones in the country in his work on wind energy availability and potentials in Nigeria.

"[13]"survey on Nigerian cities revealed that the annual wind speed ranges from 2.32m/s for Port Harcourt and 3.89m/s for Sokoto. Wind energy is yet to be used in Nigeria.

SOLAR ENERGY

The sun releases an amazing amount of energy due to the nuclear fusion of hydrogen taking place within its core. Solar panels, called photovoltaic cells are used to convert the sun's energy into electricity. The sun can also be used to heat water passing through special solar collectors. Sambo "[13]" identified two categories of solar energy technologies as solar-thermal and solar photovoltaic."[8]" reported that the annual average daily sunshine in Calabar is 6.25 hours, ranging between 3.5 hours at the coastal areas to 9.0 hours at the far northern boundary. Similarly, it has an annual average daily solar radiation of about 5.25KW/m^2/day in the coastal area and 7.0kw/m^2/day at the northern boundary. Nigeria receives about 4.851 x 1012KWh of energy per day from the sun. This huge energy resource from the sun is available for only about 26% of the day.

Garba and Bashir "[10]" proposed that the country experiences cold and dusty atmosphere during the Hamarttan in its Northern part for a period of three months (November-February) annually. The dust has an attenuation effect on the solar radiation intensity. Based on the land area of 924 x 103Km^2 for the country and an average of 5.535KWh/m^2/day, Nigeria has an average of 1.804 x 1015KWh of incident solar energy annually. This annual solar energy value is about 27 times the nation's total conventional energy resource in energy units and is over 117,000 times the amount of electric power generated in the country. Statistics shows that about 3.7% of the nation land mass is needed to utilize from the sun an amount of energy equal to the nations conventional energy reserve annually. "[14]"

The world is shifting attention from conventional sources of energy into renewable energy sources in order to reduce carbon emissions and limit the global average temperature changes. "[15]" showcases the bylaws that the government is putting in place to encourage renewable energy exploitation, whilst discouraging sources that increase environmental pollution in the form of carbon dioxide and chemicals that are hazardous to mankind. "[16]"noted that renewable energy markets are not easily formed due to cost and the subsidizing of fossil fuels. The renewable energy supply is continuously increasing as a large amount of investment has been made during the last few years. The advancement in technology has enabled countries including Nigeria to produce more energy from solar systems"[17]".

Geothermal energy

According to Dye" [18]"geothermal energy comes from the Earth's crustand originates from the original formation of the planet and from radioactive decay of minerals. Geothermal energy in recent times is known for electricity generation with 10,715 megawatts (MW) of geothermal power utilized in 24 countries. An additional 28 gigawatts of direct geothermal heating capacity is installed for district heating, space heating, spas, industrial processes, desalination and agricultural applications. Geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels. This form of renewable energy source is yet to be utilised in Nigeria. Against this background the research aims to:

- Appraise the various types of renewable energy sources available within the Calabar metropolis.
- Analyze if there is any significant shift from dependence on the conventional power sources to solar energy sources.

The research formulated a null hypotheses based on the results of this work.

2 RELATED WORKS

Solar power using photo voltaics has a more contemporary history that can be traced to 1887 when Heinrich Hertz recorded the photoelectric

effect. He examined the flow of electrons when light hits some materials thereby conducting electricity. The sun releases an amazing amount of energy due to the nuclear fusion of hydrogen taking place within its core. Solar panels called photovoltaic cells are used to convert the suns energy into electricity.
The 1973 oil crisis stimulated a rapid increase in the production of photovoltaic cells (PV). In the early 1980's, the production of PV and funding retreated due to the gradual falling of oil prices.
"[1],[19]"forecast the reduction of the world's energy needs in the nearest future since several nations around the world could utilise and depend on the natural sources for energy generation.

2.1 The Solar Energy Status in Calabar Tertiary Institutions

Renewable energy exploration in Calabar is progressing as solar energy exploitation is ongoing. The awareness of renewable energy is spreading through the city, as institutions like the University of Calabar, the Cross River State University of Technology and firms are effectively and efficiently planning to utilisesolar energy for power generation. "[20]" had made several effortsto shift dependence to solar energy utilization through the design and construction of solar multiple battery chargers."[21]"recounted the nation's potential to exploit its abundant solar energy resources considering its geographic location around the equatorial sun-belt. The delivery of 8.0KWh/m^2 maximum sunlight all year round and the abundance of 6 hours daily sunshine gives 5.86KWh/m^2/day in Calabar."[22]".
The main purpose of solar energy exploitation is to improve the electricity generation from the conventional powergeneration sources in order to achieve value for the purchasing power of the money spent on power generation eliminate power failures, which has made life unfair and paralysed both academic and economic activities in this part of the country.

3 RESEARCH METHODOLOGY

Our survey covers the two tertiary institutions located within the two local government councils in Calabar. TheLocal Government councilsareCalabar South and Calabar Municipality. These two local government areas are both located in the Southern Senatorial district in the capital of the Cross River State within the South-South geopolitical zone of Nigeria. All age categories, different strata and several ethic groups including foreign elites are found within this region; the Efiks, the Quas and the Efuts are the dominant groups, though other ethnic sojourns like the Ibibio's, Anang's, Igbo's, Yoruba's and Hausa's and others are present. These areas were mainly a trade port, but after the abolition of slave trade, it became the centre of palm oil trade and later metamorphosed into a missionary centre for educational institutions and an administrative capital for the early British rule in Nigeria. The predominant energy sources are the conventional type(hydropower and biomass) while solar energy is at the infancy stage.
The experimental survey herein employed data collection via oral interview and questionnaire.

3.1 The Questionnaire

The questionnaire assumed the form of individual completion and multiple choice questions which required respondents to tick accordingly the options they considered to be most appropriate and also give useful information where necessary.
About two thousand and fifty (2050) questionnaires on the average were administered to civil servants, businessmen, the students and even the unemployed within the identified environments. From this one thousand and sixty seven (1067) completed questionnaireswere duly returned.

3.2 Oral Interview

Questionnaires by their nature do not permit exhaustive and in depth answers to some questions. Hence, during the researcher's rounds around town, people were interviewed on the subject under review. The results of such face-to-face interviews were used to compliment other sources of information and clarify questions.

3.3 Personal Observation

The researcher also made personal observations and this also helped to clarify issues and collect more useful information for the study.

3.4 Data Analysis Technique

The data treatment technique used was Chi-square as denoted in (1)."[23]" provides an important hypothesis testing tool, which is a non-parametric statistical test that examines the frequency of two nominal scale variables to determine whether the variables have a relationship or not. "[24]"Chi-square measures the discrepancy existing between the observed and expected frequencies in a hypothetical distribution. "[25]"all of the variations use the same idea to compare the expected values with the actualobserved values. "[26]". The most common forms can be used in a contingency table"[27]". The chi-squared distribution has many uses in statistics,

including confidence interval estimation for a population; standard deviation of a normal distribution from a sample standard deviation. Independence of two criteria of classification of qualitative variables; relationships between categorical variables (contingency tables); sample variancestudy when the underlying distribution is normal.Tests of deviations of differences between expected and observed frequencies (one-way tables).

The formula for Chi-square is given thus:

$$X^2 = \frac{\Sigma(O-E)^2}{E} \quad (1)$$

Critical Chi-square distribution function:

$$F(x;\, k) = \frac{\gamma(k/2,\, x/2)}{\Gamma(k/2)} \quad (2)$$

Where$\gamma(s,\, x)$ is the lower incomplete gamma function, and $\Gamma\,(z)$ is the gamma function.

Gamma function:

$$\Gamma(z) = \int_0^\infty t^{z-1} e^{-t}\,\mathrm{d}t\,. \quad (3)$$

Lower incomplete gamma function:

$$\gamma(s, x) = \int_0^x t^{s-1} e^{-t}\,\mathrm{d}t. \quad (4)$$

where x is the upper limit of integration and s is the value of the shape parameter.

From (1) Where;

O= *Observed* frequency
E= Expected frequency
X^2= Chi-square
Σ=Summation

A chi square test will always give a probability (p-value). The p-value will always show if the test results are significant or not, which further help to decide whether to support or reject the null hypothesis. In general, small p-values **(1% to 5%)** would cause a rejection to the null hypothesis and a very large p-value means an acceptance to the null hypothesis. In order to perform a chi square test and get the p-value, the degrees of freedom and the alpha level (α) must be determined. By using the contingency table, the degree of freedom is as shown in Equation 5.

$$df = (r-1)(c-1) \quad (5)$$

Where;

df =Degree of freedom
r = Number of rows
c = Number of columns

4 RESULTS AND DATA PRESENTATION / ANALYSIS

The data used for the analysis were responses from respondents as analysed from the questionnaires administered. The respondents are presented in tabular forms and expressed in percentages as indicated in Tables 1 to 3 below.

TABLE 1
Distribution of respondents by gender

Gender	No of respondents	Percentage
Male	650	55.7
Female	517	44.3
Total	1167	100.0%

Table 1 shows the relationship between the male and female respondents. The male respondents comprised of 55.7% of the sample population, while the female respondents were 44.3%.

TABLE 2
Distribution of Respondents by Age

Categories by Age	No of Respondents	Percentage %
16-19	70	5.9
20-23	90	7.7
24-27	80	6.9
28-31	95	8.1
32-35	95	8.1
36-39	90	7.7
40-43	93	7.9
44-47	89	7.6
48-51	88	7.5
52-55	75	6.4
56-59	70	5.9
60-63	60	5.1
64-67	55	4.7
68-71	50	4.3
73-75	67	5.7
TOTAL	**1167**	**100.0%**

Table 2 shows on the average the categories of ages covered in this survey. 5.9% of the total population were those respondents within the minimum ages of 16-19 years; while 5.7% were respondentswithin the maximum age range of 73-75 years

TABLE 3.
Distribution of respondents by occupation

Occupation	No of respondents	Percentage %
Civil servant	**300**	**25.7**
Business men	**350**	**29.9**
Student	**350**	**29.9**
Unemployed/others	**167**	**14.3**
Total	**1167**	**100.0**

Table 3, gives the detailed occupations of all the respondents:25.7% were civil servants, 29.9% were businesses men and students while 14.3% were unemployed and others.

4.1 Data Interpretation/ Analysis

TABLE 4.
Distribution of respondents on the significant shift from dependence on conventional or public power sources to solar energy source

	Option / no of respondents			
Categories in ages	strongly agreed	agreed	strongly disagreed	Total
16-19	**10**	**15**	**55**	**70**
20-23	**15**	**10**	**65**	**90**
24-27	**5**	**8**	**67**	**80**
28-31	**5**	**5**	**85**	**95**
32-35	**20**	**10**	**65**	**95**
36-39	**8**	**10**	**62**	**90**
40-43	**6**	**4**	**83**	**93**
44-47	**5**	**4**	**80**	**89**
48-51	**10**	**5**	**73**	**88**
52-55	**15**	**10**	**50**	**75**
56-59	**10**	**6**	**54**	**70**
60-63	**5**	**9**	**46**	**60**
64-67	**3**	**2**	**50**	**55**
68-71	**3**	**5**	**42**	**50**
73-75	**5**	**10**	**52**	**67**
Total	**125**	**113**	**929**	**1167**
Percentage %	**10.7%**	**9.7%**	**79.6%**	**100.0 %**

The degree of freedom is
(15-1)(3-1) = $(14)(2) = 28 \sim X^2_{28}$
The critical value of 5% at 28 df= 41.34

Table 4 shows that 10.7% respondents strongly agreed that there is a significant shift from dependence on conventional power sources (hydropower and biomass) to solar energy source while 9.7% agreed that there is a little significant shift to solar energy though it is at the infancy stage, 79.6% of the total population disagreed that there is any significant shift from dependence on conventional power sources to solar energy source.

4.2 Test of Null HypothesisH_o

If*the critical value of 5% at 28 degrees of freedom (df)is less than or equal tothe chi-square statistic calculated for each tabulated option* then the null hypothesis is accepted otherwise the hypothesis is rejected. The hypothesis of table 4, is tested at 5% level of significance in order to establish the significance level of identification of acceptance and rejection of the hypothesis.

H_o: Is there any (little or great)significant shift from dependence on alternative power sources to solar energy source (H^2_{28}) analysis of (H_o)"

TABLE 0
Definition of terms used in Table 5- 7

Variables	**definition**
CA	**Categories of age**
0	**Observed**
Oa	**Observed population of the agreed option**
a	**Agreed option**
E	**Expected**
$(O-E)$	**Observed-Expected**
$(O-E)^2$	**Square of the Observed-Expected**
$0sa$	**Strongly disagree option**
Oda	**Disagree option**

TABLE 5.
The strongly agreed option (**$0sa$**) on the great significant shift from dependence onConventional power sources to Solar energy source (H^2_{28}) analysis of (H_o)

CA in $0sa$	**O**	**Expected E**	**$(O-E)$**	**$(O-E)^2$**	**$\frac{(O-E)^2}{E}$**
16-19	**10**	**8.3333**	**-1.67**	**2.7889**	**0.3347**
20-23	**15**	**8.3333**	**6.67**	**44.489**	**5.339**
24-27	**5**	**8.3333**	**-3.33**	**11.089**	**1.331**
28-31	**5**	**8.3333**	**-3.33**	**11.089**	**1.331**
32-35	**20**	**8.3333**	**11.67**	**136.18**	**16.34**
36-39	**8**	**8.3333**	**-0.33**	**0.1089**	**0.013**
40-43	**6**	**8.3333**	**-2.33**	**5.429**	**0.652**
44-47	**5**	**8.3333**	**-3.33**	**11.089**	**1.331**
48-51	**10**	**8.3333**	**-1.67**	**2.7889**	**0.3347**
52-55	**15**	**8.3333**	**6.67**	**44.489**	**5.339**
56-59	**10**	**8.3333**	**-1.67**	**2.7889**	**0.3347**
60-63	**5**	**8.3333**	**-3.33**	**11.089**	**1.331**
64-67	**3**	**8.3333**	**-5.33**	**28.408**	**3.41**
68-71	**3**	**8.3333**	**-5.33**	**28.408**	**3.41**
73-75	**5**	**8.3333**	**-3.33**	**11.089**	**1.331**
Total	**125**	**125**			**2.28**

Table 5, column one shows the categories of all respondents by age. Column two shows the average of 125 respondents of the overall population of those who strongly agreed that there isa significant shift from dependence on conventional or public power supply sources. Column three gives the Expected respondents that is calculated from dividing the observed population over the total number of rows. Column four is derived from subtracting the expected population from the observed respondents and finally the last column is obtained from dividing the square of the difference between the observed and expected respondents by the expected respondents.

Therefore from table 5, the Expected result is

$$E = \frac{125}{15} = 8.3333$$

The chi-square statistic calculated for the strongly agree option = 42.28

The Closest p-value for 42.28 is 0.04079 ~ 4.08%

Result Interpretation: from the chi-square statistical(X^2) analysis of the strongly agreed option of the H_o of table 5, the chi-square statistic is 42.28 while the critical value is 41.34

As the critical value is**(41.34 < 42.28)**chi-square statistics, the null hypothesis is rejected. It is therefore concluded that there is no great significant shift from dependence on alternative power sources to solar energy sources in the institutions inCalabarmetropolis. This deduction is based on the referral of the small p-value of4.08%.

TABLE6. The agreed (0a) option on the little significant shift from dependence onConventional power sources to solar energy source (H_{28}^2) analysis of (H_o)

From table 6, the Expected result is

CA in 0a	Oa	E	$(O-E)$	$(O-E)^2$	$\frac{(O-E)^2}{E}$
16-19	15	7.533	7.467	55.76	0.81
20-23	10	7.533	2.467	6.086	0.03
24-27	8	7.533	0.467	0.218	0.03
28-31	5	7.533	-2.533	6.416	0.85
32-35	10	7.533	2.467	6.086	0.03
36-39	10	7.533	2.467	6.086	0.03
40-43	4	7.533	-3.533	12.482	1.66
44-47	4	7.533	-3.533	12.482	1.66
48-51	5	7.533	-2.533	6.416	0.85
52-55	10	7.533	2.467	6.086	0.03
56-59	6	7.533	-1.533	2.350	0.32
60-63	9	7.533	1.467	2.152	0.29
64-67	2	7.533	-5.533	30.614	4.06
68-71	5	7.533	-2.533	6.416	0.85
73-75	10	7.533	2.467	6.086	0.03
Total	113	113			11.53

$$E = \frac{113}{15} = 7.5333$$

The chi-square statistic calculated for the (Oa) option = 11.53

The Closest p-value for 11.53 is 0.9974 ~ 99.74%

Result Interpretation: from *the chi-square statistic*(X^2) analysis of the agreed option of the H_o of table 6, the *chi-square statistic is 11.53* while the critical value is 41.34

As the critical value is **(41.34 > 11.53)** the *chi-square statistics*, the null hypothesis is accepted. It is therefore concluded that there is little significant shift from dependence on conventional power sources to solar energy source in the institutions in Cross River State though the development may be in the infancy stage. This deduction is based on the referral of the large p-value of *99.74%*.

TABLE 7

The disagreed (Oda) option on the significant shift from dependence onConventional power sources to solar energy source (H_{28}^2) analysis of (H_o)

CA in (Oda)	Oda	E	$(O-E)$	$(O-E)^2$	$\frac{(O-E)^2}{E}$
16-19	55	61.93	-6.933	98.605	1.6
20-23	65	61.93	3.07	9.425	1.5
24-27	67	61.93	5.07	25.705	0.42
28-31	85	61.93	23.07	532.2	8.59
32-35	65	61.93	3.07	9.425	1.5
36-39	62	61.93	0.07	0.005	0.000
40-43	83	61.93	21.07	443.9	7.17
44-47	80	61.93	18.07	326.5	5.27
48-51	73	61.93	11.07	122.5	1.98
52-55	50	61.93	-11.93	142.3	2.30
56-59	54	61.93	-7.93	62.88	1.02
60-63	46	61.93	-15.93	253.8	4.10
64-67	50	61.93	-11.93	142.3	2.30
68-71	42	61.93	-19.93	397.2	6.41
73-75	52	61.93	-9.93	98.6	1.6
Total	929	929			45.76

From table 7, it was observed that the Expected result is

$$E = \frac{929}{15} = 45.76$$

The chi-square statistic calculated for the disagreed option = 45.76

The Closest p-value for 45.76is = 0.01845 ~ 1.85%

Result Interpretation: from *the chi-square statistic* X^2 analysis of the(Oda) option of the H_o of table 7, the *chi-square statistic is 45.76* while the critical value is 41.34

As the critical value is (41.34 < 45.76), the null hypothesis is rejected. It is therefore concluded that there is nosignificant shift from dependence on conventional power sources to solar energy sources

in Calabar tertiary institutions. This deduction is based on the referral of the small p-value of 1.*85%*.

5 DISCUSSION OF FINDINGS

The thrust of this study is to review the extent to which solar energy is harnessed in the various tertiary institutions within the city of Calabar, the capital of the Cross River State.

The general perception is that renewable energy (solar in particular) has brought significant improvement in power generation to many nations that have exploit it. Since the tertiary institutions are the pace setters, it is believed that they ought to be the driving force of all development in any nation. So to verify our intuition with accurate proof, anexperiment was conducted by modelling a null hypothesis to determine if there is any significant shift from dependence on conventional energy sources (biomass which is the burning of coal and fire wood to generate heat) and hydropower which has been in existence prior solar energy source. The respondents in Table 5, 6 and 7, show that solar energy which is the only source of renewable energy in this institutions is at the infancy stage but has great prospects for economic advancement when developed properly.

From Table 5 to 7, the respondents shows that there is little or no significant shift to solar technology energy sources because only a few people are actually using solar energy.

From the researcher's oral interview it was discovered that the predominance of conventional energy sources is due to cost, ignorance, dishonesty and illiteracy.

Ignorance: The populace are unfamiliar with the benefits and effectiveness of solar technology and its capability in improving the nation's insurmountable challenge of inadequate public power supply, poor infrastructure and living standards.

Cost: Major companies supplying solar technology (panels) and the required accessories are not resident in Calabar. It is therefore very expensive to purchase materials out of the state for the smallest solar installation. Due to the present downturn in the economy and high exchange rate in the parallel market, the standard of living has dropped generally as well as cost of solar panels and its accessories increasing in Nigeria andCalabar in particular.

Dishonesty: It is very difficult to purchase original components and materials to install and maintain a solar grid due to fake and substandard materials, as such the durability of the installation is not guaranteed.

Illiteracy: So many are not enlightened on the existence and luxury of a reliable and clean power supply. There is no marketing or significant campaigns organised to create enough awareness on the benefits of solar energy.

6 CONCLUSION

Hitherto, renewable energy sources were synonymous with developed nations. However, owing to the challenges of a grossly unreliable power supply in Nigeria, there is a requirement to change from the traditional means of supplying power and supplement it with solar energy, such a change has become an imperative. For academic and economic activities to thrive and grow, the daily power supply must be continuous and permanent.

This study reveals that there is little significant shift from the usage of biomass and hydropower to solar panels as seen on roof-tops, on street lights, and domestic appliances such as solar lamps, solar chargers, solar fans, solar batteries, etc. The few individuals that usesolar energy as a source of power confirm that it can provide twenty four hour power, with no power failure. It is therefore a call for business men and entrepreneurial interests to explore this business opportunity to compliment the power needs in Calabar, the various institutions and Nigeria in general asthe benefits of solar energy cannot be over emphasized. Thus:

a) A clean energy devoid of dangerous emissions of gases that causes health problems.
b) An energy supply without the costof fuel or gas.
c) A low maintenance noiseless energy without mechanical moving parts.
d) Economic benefits by investing in production facilities

Nevertheless there are limitations, thus:

Initial purchase and installations very expensive:Limited power supply due to load assessment needs during installation; high cost of PV array and ancillary equipment.

Shadow or shading: a major effect on the general performance of a photovoltaic module. Shading affects the output voltage, output current and its rated power.

Literacy: must be literate to use solar energy source and solar energy is intermittent with respect to climatic and whether conditions. Therefore the researcher has made some underpinning **recommendations** as a way of reducing the burden of over-dependence on the public power supply(conventional energy sources),encouraging participation towards considering its competitive challenges and problems as well:

i. The Nigerian government should endlessly encourage young entrepreneurs to invest in solar panel manufacturing companies within the country.
ii. Multinational companies manufacturing solar panels and the required accessories should be encouragedby regulating tax policies on products of this kinds.
iii. The government should give financial assistance to entrepreneurs who possess the expertise to start businesses in this area.
iv. The Federal Government should make alternative power sources (solar energy) anurgent national

priority by incorporating it into the nation's yearly budget especially for tertiary institutions.

v. The Federal Government should make research grants available through the agencies tasked with such responsibilities in order to encourage more research in this area.

REFERENCES

[1] O.Ellabba,H. Abu-rub and F.Blaabjerb,"Renewable energy and sustainable energy review" (2014). 39, 74-764 pg 749.

[2] **O.**Ibidapo-ObeO.and O.O.Ajibola,"Towards a renewable energy development for rural sufficiency" International conference on innovations in Engineering and Technology (IET 2011), August 10th, 2011.

[3] A.V. Herzog, T.E. Lipman, J.L. Edwards & D.M. Kammen," Renewable energy: A viable choice" (2001). Pg -20

[4] U.O. Aliyu, and S.B. Elegba, "Prospects for Small Hydropower Development for Rural Applications in Nigeria". Nigerian Journal of Renewable Energy. (1990).Volume 1

[5] **I.** Edjekumhene, "Status of Renewable Energy and Energy Efficiency Systems in West Africa". Background Paper Prepared for the West African Regional REEEP Consultation Meeting in Accra, June, 2003

[6] **A.S.** Sambo,"Renewable energy for Rural Development: The Nigerian perspective," Isesco Science & Technology vision Volume 1(2005).

[7] J-F.K. Akinbami, "Renewable Energy Resources and Technologies In Nigeria: Present Situation, Future Prospects And Policy Framework," *Mitigation and Adaptation Strategies for Global Change* 6: 155–181, 2001. *Kluwer Academic Publishers. Printed in the Netherlands.*

[8] E.N. Okafor.and J-Uzuegbu, "Challenges to Development of Renewable Energy for Electric Power sector in Nigeria," International Jornal of Academic Research. Vol. 2. No. 2. March 2010

[9] C.B. Field, M.J. Behrenfeld, J.T.Randerson& P. Falkwoski, "Primary production of biosphere: integrating Terrestrial &Oceanic components" 1999. Science 21 (5374): 237-240

[10] B.Garba, and A.M.Bashir, "Managing Energy Resources in Nigeria: Studies on Energy Consumption Pattern in Selected Rural Areas in Sokoto State", Nigerian Journal of Renewable Energy, Vol. 10 Nos. 1&2, pp. 97-107

[11] J-F.K.Akinbami, M.O.Ilori, T.O. Oyebisi, I.O. Akinwumi, and O. Adeoti, "Biogas energy use in Nigeria: Current status, future prospects and policy implications,"*Renewable and Sustainable Energy Review*, **5**, 97–112 (2001)

[12] J.O. Ojosu and R.I Saluwu, "A statistical analysis for wind energy in Nigeria," solar and wind technology, vol. 7. Pp. 155-167 (1989).

[13] A.S. Sambo, "Wind energy assisted solar electricity generating schemes for the rural areas of Nigeria; large scale systems in developing countries" (Ovuworie, G.c, Onibere E. A. and Asalor J. O. (Eds) 1987, pg 45-160

[14] M.A. Mayowa, "Nigeria's per capita electricity consumption is among others the lowest in the world," 2016 (http://www.drumbeatnews.com)

[15] S. Albolhesseini, A.Heshmati, and J.Altmann, "A review of renewable energy supply and energy efficiency technologies," 2014 Paper number 145, 4.

[16] S.Jacobson, and A. Bergek, "Transforming the system energy: the evolution of technological systems in Renewable energy technology," Industrial and corporate, 13 (5), 15-49 2004.

[17] IEA, "Medium term renewable energy market report 2012. OECD publishing,". (http://www.wordpress.com)

[18] S.T. Dye, "Geoneutrinos, and the radioactive power of the Earth", Review of Geophysics 50(3).2012

[19] N. Danielson, "U.S green technology"http://www.myenergygateway.org.html 2013 (retrieved 28/12/2016)

[20] F. Faithpraise, D.Bassey, M. Charles, Mfon, O. Osahon, M. Udoh, C. Chatwin, "Experimental Design and Construction of an Enhanced Solar Battery Charger," *.IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 11, Issue 2 Ver. III (Mar. – Apr. 2016), PP 11-16 www.iosrjournals.org* DOI: 10.9790/1676-1102031116 www.iosrjournals.org

[21] O.C. Iloeje, "Renewable Energy Development in Nigeria: Status & Prospects". In: Ewah, O. E. (Ed) (2002). Proceedings of a National Workshop on "Energising Rural Transformation in Nigeria: Scaling up Electricity Access and Renewable Energy Market Development". Federal Ministry of Power and Steel, Abuja, Nigeria. March 19 – 20, 2001. 180pp. ICEED

[22]A.S.Sambo "Strategic Developments in Renewable Energy in Nigeria," 2009 International Association of Energy Economics. 3rd Quarters 2: 15-19

[23] G.W. Corder,&D.I. Foreman, "Nonparametric Statistics: A Step-by-Step Approach,"2014 Wiley, New York. ISBN 978-1118840313

[24] B.YaRyabko, V.S. Stognienko, Yu.I. Shokin, Yu.I,*."A* new test for randomness and its application to some cryptographic problems," Journal of Statistical Planning and Inference. (2004).**123**: 365–376. *(Retrieved 18 February 2015)*

[25] F.Yates, "Contingency table involving small numbers and the χ^2 test,"*Supplement to the Journal of the Royal Statistical Society*1934).**1**(2): 217–235

[26] J. Cuzzi, "T*he* Subsurface Nature of Mercury and Mars from Thermal Microwave Emission," Ph.D. Thesis. Pasadena, CA: California Institute of Technology, 1972.

[27] J.F.Kenney, and E.S. Keeping, "Mathematics of Statistics", Pt. 2, 2nd ed.Princeton, NJ: Van Nostrand, 1951.