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Study Assessing Viability of Installing 20kw Solar Power for the Electrical & Electronic Engineering Department Rufus Giwa Polytechnic Owo

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Abstract:- The practicality of solar power supply to the Electrical and Electronics Engineering Technology department at Rufus Giwa Polytechnic, Owo, is the main topic of this article. Some other sources of power were put into consideration. Solar power was selected as an alternative supply to the department due to its numerical advantages over others. The authors looked into the various effects in the past by different researchers in ensuring that the best is obtained from solar energy. The load estimation was carried out by considering the possible load from various units within the department. The power consumption demand was calculated. Also, the photovoltaic panel capacity and quantity were estimated. Data collection was done over the course of three days. The voltages generated by the photovoltaic panel on an hourly basis were recorded. These form the basis for plotting graphs that reveal the feasibility of the project in the institution.

Keywords:- *Estimation, Load, Photovoltaic, Solar, Supply, Voltage.*

I. INTRODUCTION

Academic growth in our educational institutions is supported by a variety of energy sources. Making plans for the institution's need for safe, economical, and reliable energy services can help with a variety of challenges. Since there is a limit to our reserves of fossil fuel, it is now commonly acknowledged that the growth in energy consumption that has been observed for many years cannot continue indefinitely.

Our society needs energy for its growth in order to improve the standard of living and the smooth operation of the other sectors of our economy. The use of energy resources has been regarded as one of today's most significant and ongoing studies. Currently, almost two billion people worldwide live without electricity [1, 2]. Increased reliance on technology, higher living standards, and continuous population growth contribute to rising energy consumption. Fossil fuels are being consumed more often to meet the world's energy needs, which have a negative impact on the environment, the ozone layer, climate change, and the health of all living things.

Energy use per capita has increased along with economic development, and the level of living and energy consumption per capita is strongly correlated. Although it is by no means the only factor influencing our growth, energy production has had a significant impact on how society is organized. Generally, fossil fuels, nuclear power and renewable energy sources are the three main categories of energy sources. [3]

Renewable energy is widely recognized and accepted due to its significant contributions in the world's energy future. Renewable sources can be utilized repeatedly to provide energy, examples of these are solar, wind, biomass, biofuels, marine, geothermal and many others [4, 5]. Renewable energy sources help in electricity bill savings, it is noiseless, produce no air pollution, and guaranteed a healthier environment through the reduction of greenhouse gas (GHG) emissions [6]. As good as many renewable energy technologies are being used, many of the technologies are still under development. Currently, in the world's energy mix, renewable energy sources supply about 23.7% of the total global energy demand [7] up from 2% in 1998 when modern biomass accounted for two exajoules and all other renewable energy sources for seven exajoules [8]

The global future may be significantly impacted by renewable energy sources. By generating zero or almost zero percent of these gases, renewable energy sources can supply energy free of air pollution and greenhouse gases [9].

It is a stable, affordable, and environmentally friendly approach to fulfil the decentralized energy needs of rural and small-scale communities. [10,11]. Although there are several renewable energy technologies in use today, many of them are still in the development stage.

Solar energy is one of the most common renewable technologies as it directly harnesses sunlight to produce electricity for human use as well as energy for buildings, transportation, and industrial activities. Given the size of the solar resource, these technologies are less restricted by feedstock needs than by prices and "institutional" barriers including performance (for example, intermittent operation), perceived hazards, and siting concerns. The use of photovoltaic cells or solar panels is now much more pronounced almost in every part of the world. The cells are made of semiconductor materials similar to those found in computer chips [12]. When sunlight hits the cells, electrons

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flow and this generates electricity on a much larger scale. The most plentiful source of energy we have is solar energy. It is approximated that 10000 TW worth of solar energy is incident on earth's surface in a day [13, 14].

The pursuit of new alternative sources of energy and the conservation of energy is a task for energy research and Rufus Giwa Polytechnic, Owo (RUGIPO), formally known as "Ondo State Polytechnic, Owo (OSPO)" is not an exemption. It is therefore required to discover new sources of energy, obtain a sufficient supply of energy for the future, make energy from one form to another, and utilize it with minimal adverse environmental effects.

RUGIPO is the oldest of the four tertiary Institutions in the state [15]. The Polytechnic was established in the year 1979, started operation fully in 1980, and was accredited [16] by appropriate authorities. However, there are major hindrances to widespread energy access, especially electricity within the system which can be traced to poor financing, lack of planning, poor governance, and human and institutional capabilities.

It is important to observe that though Ondo State as a whole is rich in energy resources, the supply of energy is very poor. Making reliable energy widely available to all the units in the Electrical department, therefore, becomes necessary to the development of a department that accounts for 12% of the Institution's population and consumes about 35% of the energy needed.

Since the supply from the public utility company known as Benin Electricity Distribution Company (BEDC) has failed to meet the public expectation of uninterrupted power supply which is also at times dropped below the appropriate level suitable for use, it has justified the need to seek for an alternative source of power which is a solar energy system. This energy is available wherever it is needed, and can also be converted from one form to another.

Several thousands of people in RUGIPO do not have access to constant electricity. Each of the departments in the Institution is now making use of either a Diesel Power Generator (DPG) or Petroleum Power Generator (PPG) which produce harmful exhaust, to meet its energy demand. These other means of power supply have their own disadvantages such as high cost of maintenance, noise pollution, environmental pollution, etc. which are harmful to the community.

The central DPG which serves as the main source of energy is not big enough to meet the power demands of the whole Institution. The scenario is even gloomier when the entire population of both the staff and students keeps increasing right from the year 2012, the energy consumption of the institution is more than what it used to be in the last decade.

In this paper, solar renewable energy technology is used to design and implement 20kW to meet the total energy demand for the Department of Electrical Electronic Engineering Technology in RUGIPO. The solar power system is discussed as one of the best renewable energy technologies which is not only cost-effective but environment friendly as well. The off-grid solar system of 20kW capacity is considered to be completely dependent on solar energy. A battery backup will be used as electric power storage to be used when there is no sunlight to hit the panels, especially at night. The paper focuses on how the methodology of the off-grid system helps to reduce the dependency on the general power supply. The department can now live in a self-sufficient manner without too much reliance on the main utility provider while the fuelling cost of the institution's Diesel Power Generator (DPG) is greatly reduced. The paper is aimed to engage academic institutions to get insight into the new and emerging renewable energy technologies and quality research.

II. LITERATURE REVIEW

Feasibility Study on 20Kva Solar Power Supply to Electrical and Electronics Department, Rufus Giwa Polytechnic, Owo. Solar energy is free, abundant, and limitless in nature but is faced with technological barriers to its collection, distribution, and storage. Meanwhile, harnessing it through technology will contribute to poverty alleviation by providing the energy needed for creating businesses in both rural and urban communities not connected to the grid or without quality supply respectively. PV Cells is estimated to produce 1081GW by the year 2030 [19].

Solar energy generation is an alternative source to cater for the energy deficit in Nigeria resulting in load shedding. 4000MW available power cannot match the predicted load demand excluding suppressed load of about 10,282 MW by the year 2020 [20]. Airports and countries are adopting solar energy amidst its variability in power generation. India's Cochin International Airport became the first to run entirely on solar power in 2015, and many nations, including Nigeria, encourage solar adoption to meet specific established targets. [20, 22]

Generating electricity from the sun with PV technology has advantages and disadvantages. The benefits outweighed the drawbacks and included low operational and maintenance costs, a long lifespan of 20 to 30 years between failures, no moving parts during operation, availability of PV panels in various sizes or modules over a wide range of power ratings, environmental friendliness, global warming, and ozone layer depletion. [19].

A study by [20] selected fourteen locations in Nigeria to investigate the feasibility of solar farm sites, and the technical and economic viability in Nigeria. [19, 20], PV panel technology is a method that utilizes solar radiation for energy generation through the use of necessary infrastructure, equipment and facilities, and skilled personnel. Photovoltaic data varies across different manufacturers. There is an effect of different values of moderation due to different manufacturers' tolerance of the temperature coefficient of power. A lower temperature

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coefficient of power produces a higher capacity factor and performance ratio in modules.

The climatic condition of an area is an important factor in planning solar farms because PV panel performance is determined by the meteorological effect on the module. The climate of coastal areas prevents the good performance of photovoltaic systems [18]. Because the solar cell is made in such a manner that even a small amount of shade on one panel may ultimately impede solar power generation, atmospheric shading occurs when the movement of clouds casts their shadow on the earth's surface.

Solar serves as a tool for providing the electrical energy needs of consumers. Different methods and simulations exist to determine the feasibility of using solar to meet the increasing energy need. The Techno-Economic Feasibility of Grid-Connected Solar PV System at Near East University Hospital, Northern Cyprus, 2021 [23] evaluated the solar energy potential of NUE Hospital using four datasets: actual measurement, Satellite Application Facility on Climate Monitoring (CMSAF), Surface Radiation Data Set-Heliosat (SARAH), and ERA-5. The results are encouraging. The impact of orientation angle on PV production was examined using the RET Screen Expert software, and the results were compared with the ideal orientation angles discovered using the modelling software for the Photovoltaic Geographical Information System (PVGIS). A significant element affecting PV output, capacity factor, indices of economic viability, and CO2 emissions is orientation angle.

Feasibility assessment requires data collection for the purpose of simulation from reliable sources which includes but is not limited to Meteorological agencies, online databases for daily radiation or wind speed with location-specific, and Load profiles for load calculations. These are required for optimization modelling and sensitivity analysis. RET Screen software, Homer is such that makes the reports more scientific to substantiate the feasibility [17, 21].

A community of 200 homes, a health centre, and a school with a specified load profile can be easily and economically supplied with a hybrid system of wind-PV [17]. The value of LCOE for both standalone and hybrid was found to be competitive with grid electricity. In Nigeria, many research studies exist that assessed the feasibility of Standalone PV and renewable hybrid potential for power generation but lack the scope of a university arrangement that contains laboratories.

This study is focused on the assessment of the potential and economic viability of standalone PV power generation in Rufus Giwa Polytechnic, southwest Nigeria for the Department of Electrical comprising HOD office, administrative staff offices, Laboratories, Classrooms, and convenience rooms with different electrical appliances.

III. RESEARCH METHODOLOGY AND SITE SUITABILITY

The selected location for the solar power project is the Department of Electrical and Electronics Engineering, Rufus Giwa Polytechnic, Owo. The sun radiation hour per day had been observed in the selected location to be adequate. It however ranges between 4 to 5 hours per day. Also, the location is elevated as such shade and shadow will not cover the photovoltaic (PV) panels. In order to ensure the feasibility of the solar farm, an investigation into the available sun/radiation hour per day is necessary using solar equipment and measuring instrument.

- *Solar Component Selection*

Superior/genuine solar panels have been sought from the market. Also, the most efficient solar components such as inverters, and charge controllers, among others, would be sought and installed. For instance, mono-crystalline photovoltaic panels (PV) would be used for this feasibility study due to the fact that it is more efficient than polycrystalline photovoltaic (PV) panels.

- *Solar Component Capacity Determination*

These are the procedures for the determination of the solar panel capacity.

- *Power Consumption Demand*

$$\textit{Total watt-hour per day of appliance used} = \textit{Power (P) X Hours (T)}$$

To cater for energy loss in the system, we multiply watt-hour/day by 1.3

Hence,

$$\textit{Total Photovoltaic (PV) energy needed} = 1.3 \textit{ X PT watt-hour/day}$$

- *Photovoltaic (PV) Panel Capacity and Quantity Needed*

Let's put the panel's generation factor to be between the ranges 4.8-5.5 hours per day. Determine the watt-peak (W) of PV panel as:

$$\text{Photovoltaic (PV) panel capacity and quantity needed} = \frac{\text{Total photovoltaic (PV) energy needed}}{4.8\,(\text{Generation/factor})}$$

$$= \frac{1.3PT}{4.8}$$

Table 1 Load Estimate

S/N	Load	Consumption
1	Basic Electricity Laboratory	2000
2	Machine Laboratory	2000
3	Telecommunication Laboratory	2000
4	Skill-G Laboratory	2000
5	Power Laboratory	2000
6	Maintenance Laboratory	2000

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7	HOD's Office	2000
8	Dr. (Engr.) Oluwajobi's Office	2000
9	2 Stores	60
10	ND II Lecture Room	700
11	HND II Lecture Room	700
12	Security Lamp	500
13	Administrative Office	200
14	Part-Time Unit Office	180
15	EET ND IA Lecture Room	800
16	Digital Laboratory	700
	Total	19840

- *This Corresponds to 20,000W i.e. 20kW*

Number of PV needed is calculated by dividing total watt-peak of PV needed by the rated output watt-peak of the PV panel available (www.leonics.com)

- *System Power Demand*

Power demand= 20kW= 20000W

Expected working hours= 6hours

Hence,

Total Watt-hour/day of load= P X T

= 20kW X 6

= 120000Wh/day

Hence, Total Photovoltaic (PV) energy needed= 1.1 X 120000

= 132000Wh/day

- *Photovoltaic Panel Capacity and Quantity*

$$\text{Total Watt} - \text{peak of PV panel need} = \frac{\text{Total photovoltaic (PV) energy needed}}{\text{Panel Generation factor}}$$

$$= \frac{1.3PT}{4.8}$$

$$= \frac{1.3 \text{ X } 20000}{4.8}$$

$$= 27500\text{W}$$

If 250W panel would be used quantity needed

$$= \frac{27500}{250}$$

$$= 110$$

That is 110 panels rated 250W

For 250W panels, it would be arranged as 5 panels in series in 22 places

$$= \frac{110}{5}$$

$$= 22$$

- *Note:*

The voltage from the panel must be higher than that of the battery. (Solanki C.S. 2013).

IV. DATA COLLECTION AND ANALYSIS

In order to show the feasibility of solar power supply in the selected location, the following data were obtained from a solar capacity photovoltaic panel.

The table of voltage versus time for three days is tabulated below. With time indicated as H(t), Voltage reading for day 1 as V1, Voltage reading for day 2 as V2, and Voltage reading for day 3 as V3.

Table 2 Table of Voltage Versus Time for Three Days

H(t)	V 1 (5/4/22)	V 2 (6/4/22)	V 3 (7/4/22)
10:00am	20.5	22.5	23
10:30am	22	25	24
11:00am	24.5	26	25
11:30am	25	27	26.5
12:00noon	27	28	27.5
12:30pm	28	29.5	28
01:00pm	29	29.5	28.5
01:30pm	30	30	29
02:00pm	30	29.5	30
02:30pm	30	29.5	30
03:00pm	29.5	28	29
03:30pm	28	28	28.5
04:00pm	27.5	26.5	27.5

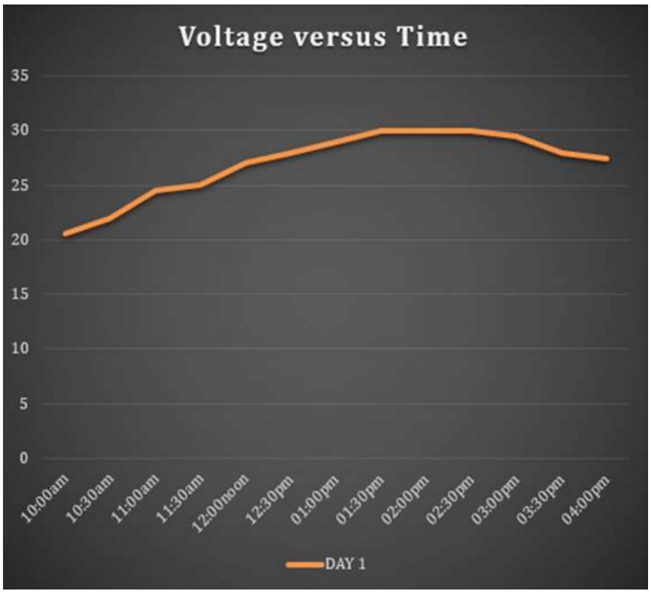

Fig 1 Graph of PV Generated Voltage Against Time for Day 1

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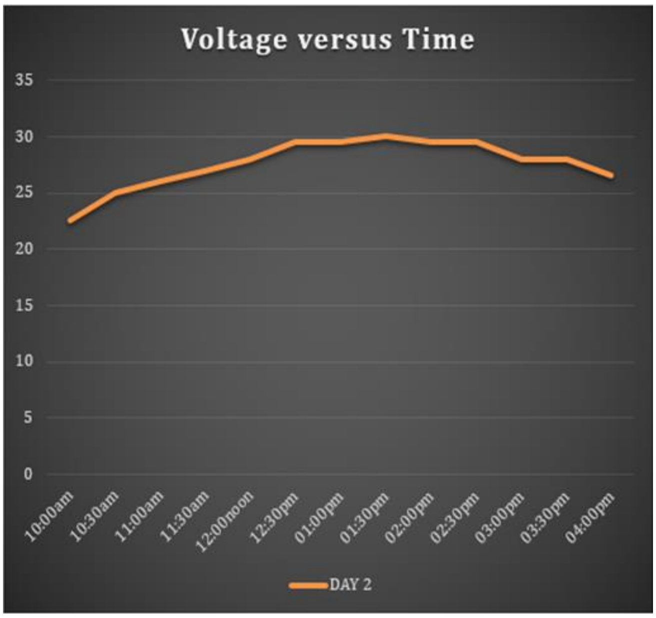

Fig 2 Graph of PV Generated Voltage Against Time for Day 2

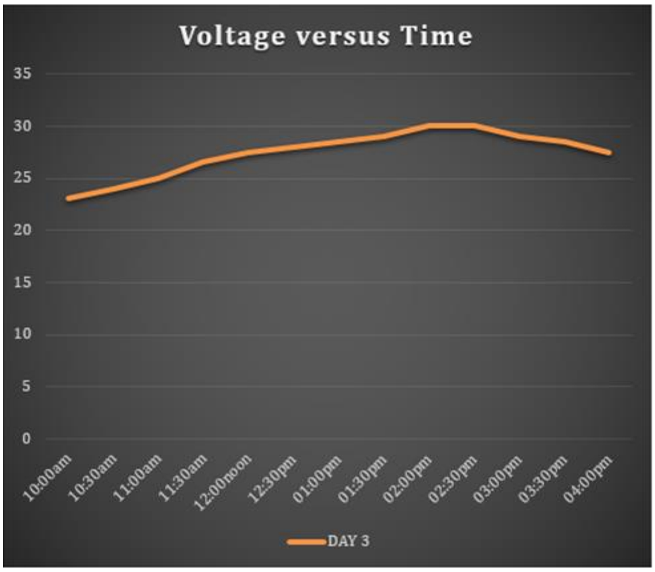

Fig 3 Graph of PV Generated Voltage Against Time for Day 3

V. CONCLUSION

The feasibility study is very essential before embarking on any project as it reveals the chances of success or failure. The graph of voltage versus time plotted above i.e. figures 1 to 3 indicated that the solar power project would be a success. A reasonable quantity of voltage was generated by the solar panel between the hours of 10 am and 4 pm. The success of the entire system would be based on the use of genuine solar components and the existing sun radiation hour per day in the selected location. The sun's radiation hour per day is high enough to support the solar project.

We recommend that the solar power project should commence as soon as possible since the feasibility study allows it.

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