DESIGN AND CONSTRUCTION OF A SOLAR ENERGY SYSTEM TRAINING AIDS FOR SKILLS & ECONOMIC DEVELOPMENT IN AFRICA: A CASE OF THE FEDERAL POLYTECHNIC ILARO, OGUN STATE NIGERIA

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Abstract

The skills, abilities, attitudes, and orientation of the students toward research and technical work can be recognized as a result of teaching and learning activities. Inadequate training facilities, poor physical and social conditions may compromise the effectiveness of instruction and learning. Setting up a supportive environment is crucial for efficient instruction and learning of useful knowledge and skills. Students in Electrical/Electronic Engineering related discipline could benefit from training in solar energy system design and installation through the use of practical training aids by understanding the application of what they are learning in a real-world setting. In this research, solar system training aid was developed. The development of the model is as the result of taken adequate design consideration/analysis, choice of the components, units testing/simulation while the overall hardware wiring and implementation was guided by standard electrical configuration techniques. The youth trained on such facility can subsequently start their own business to meet the country's needs for solar energy system design, procurement, installation, capability testing and maintenance. In order to fulfill the population's growing need, this will significantly lead to job creation, employment, and the production of electricity.

Keywords: *Employment, Job creation, learning activities, solar energy, Skills, Training aids*

Introduction

Electricity is an essential component of nature and most extensively used kinds of energy. It is a secondary energy source, which can be obtain through the conversion of primary energy sources like natural gas, coal, oil, sunlight, and other natural sources. Although the energy sources we utilize to generate electricity might either be renewable or non-renewable. EIA, (2007)

Electrical energy is a crucial element for the growth of any economy and by extension, for prosperity. According to Ekwe & Ukoima (2019), an economy is predicted to grow by 3.94% for every 1% increase in electrical energy supply. Electricity supply efficiency has an impact on possible investment decisions as well as returns on investments in already-existing businesses.

Asubiojo (2017) contends that an appropriate provision and supply of electricity is technically necessary for the development of the Nigerian economy as an emerging market. Similar to this, Okafor (2008) contends that Nigeria's industrial development has been significantly hampered by insufficient electricity generation. In a similar vein, Rabiu (2009) asserts that the Nigerian economy has faced a significant challenge for decades due to the inadequate supply and accessibility of electricity service, and that resolving this issue would strengthen the economy and lower unemployment.

The constant unstable supply of electricity in many parts of Nigeria is now the order of the day. It is no longer a new story that out of the supposed total installed capacity of about (13,000MW), only (2,497.40 MW) is available. Abubakar Aliyu, Nigeria's power minister acknowledged that the country's present electricity generation could not support the economy of more than 200 Million Nigerians Addeh, (2022).

Nigeria must therefore diversify by utilizing the wealth of renewable resources that it possesses. This paper aims to draw attention to the development of a solar system training facility at the Federal Polytechnic Ilaro for the purpose of instructing students in the design and installation of solar power systems and ensuring that the design requirements are met. The young people who have received the necessary training can then establish their own company to meet the country's needs for solar power system design, *site surveying,* procurement, installation, capability testing, and maintenance. This will tremendously improve youth employment, security and the electric power generation in Nigeria in order to meet the electricity growing demand of its populace.

Motivation

When compared to the required energy demand, which might be as high as 25,000MW, Nigeria's total power generation capacity is frequently less than 4000MW, leaving 65% to 72% of the country's rural areas without access to electricity Awosope (2015).

According to Joy (2017), the populous in rural areas in Nigeria suffers from severe poverty as a result of the absence of the fundamental infrastructures some which are essential for major productive activities for economic growth and development in modern society.

Nigeria is known for its vast open spaces and remote, outlying communities, many of whose residents are peasant farmers living below the poverty line. These regions lack basic infrastructures like a road network, water supply, and electricity among other things, Ismaila (2017). Many farmers abstain from taking part in activities beyond subsistence agriculture due to lack of contemporary energy-dependent storage facilities, Josua (2014).

According to Olusola et al (2017) Biomass, hydropower, solar, wind and other renewable energy sources are available in Nigeria. These resources are capable of meeting the nation's energy demands; however, figures indicate that Nigeria still lacks the necessary supplies to meet its electricity demands.

However, upgrading the current energy sources to include feasible and sustainable renewable energy resources is the general solution for the country and a possibility for off-grid electrification in rural areas. The solar energy falls under the category of these resources, and they are regarded as inexpensive, simple to use, widely available, naturally applicable, non-depleting, and non-toxic sources of useful and usable energy.

On January 30, 2023, Nigerian President Muhammadu Buhari commissioned the $16 million, 10-megawatt solar power project in Kano state. The project's goal is to revitalize the state's ailing industries by providing the electricity needed to run their massive operations. The plant, which was built by an indigenous local contractor and their international partners, contains more than 21,000 solar PV panels, two 6MVA transformers, 52 inverters, a state-of-the-art warehouse, a control room, and workshop building, among other others. A total of 2,000 direct and indirect jobs have been created by the initiative for the neighborhood. Abdullahi (2023)

Research Objectives

The paper is aimed at:

i. Identify various training strategies for TVET students towards improving technical education in Nigeria
i. Developing a solar energy system training facilities for the development of vocational and technical education in Nigeria.
ii. Identify the impact of TVET students training on modern technological trend for the development of Agro-Industry in Nigeria.

The Federal Polytechnic Ilaro

Study Area: The Federal Polytechnic, Ilaro constituted the study area. The Federal Polytechnic Decree 33 (1979) authorized the establishment of the Polytechnic, which has the responsibility for offering full-time and part-time National Diploma (ND) and Higher National Diploma (HND) programs in applied science, technology, management, and business. As a result, it generates technically competent labor for Nigeria's development in a variety of sectors, including industrial and agricultural production. In the five colleges of the Polytechnic—Pure & Applied Sciences, Engineering, Environmental studies, Communication & Information Technology, and management—there are about 10,000 students enrolled in courses in Science, Technology, and Management.

The general objective of the Polytechnic is to provide technical and practical oriented training to meet the manpower requirements for the industrial, agriculture, commercial and economic development of Nigeria.

Federal Polytechnic Ilaro's strategy for training TVET Students on solar energy system

In her effort to achieve its objective, the Federal Polytechnic Ilaro keyed into training of her staff on Embedded system, Robotics and Drone technology with well-equipped centre, innovation centre headed by a director. The centre was made open to staff for them to put their ideas into invention through adequate research facilities available at the centre and to come up with innovative ideas that can bring about industrial change.

Methodology

Designs Analysis

In designing this system, standard and specification of each of the electrical equipment been used are considered. Electrical hardware wiring techniques guided the overall construction of the system model. The following equipment constituted the developed system model;

Photovoltaic or PV system: this is used to convert solar or light energy into electricity. The basic component of a PV system is known as a solar cell. A single cell has the capacity of producing about 0.5volts of electricity. A solar panel or solar module is a combination of several solar cells connected in series to generate usable voltage. The solar panel voltage can be increase by increasing the number of solar cells. Example 30 solar cells connected in series will produce output of 15volts. A combination of solar panel connected together is known as solar array and can be use to achieve the required current and voltage. Figure 1.0 show the PV system used in this project.

Figure 1.0: the PV system

The inverter: A 300W portable inverter was used; it has terminals for batter connection, a fan to keep it cool after delivering high power, AC output, a switch to select either to use Li-lion or lead acid battery, a 5V USB port and a voltage level to indicate the level of the battery. Figure 2.0 shows the picture of an Inverter device

Figure 2.0 Inverter system

Battery: Deep cycle battery was used which is basically a high performance battery up to the last minute capable of handling numerous discharge cycles and also capable of getting a constant current. Figure 3.0 show the 12V100AH deep cycle battery for storing energy.

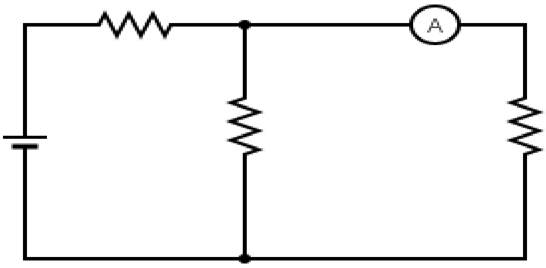
Figure 3.0: the 12V100AH deep cycle battery

Charge Controller

This device is used to detect the voltage of the battery bank and turn ON or OFF the power. It also controls the charging process in that when the battery is fully charged, the controller will switches to the float charging which is basically keeping the current coming into the battery from discharging. Figure 4.0 shows the picture of a PWM solar charge controller.

Figure 4.0 shows the picture of a PWM solar charge controller

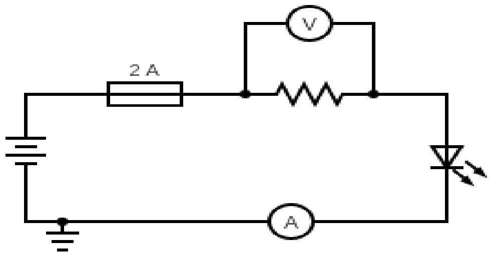
Ammeter (Ampere Meter) is a measuring instrument used to measure the current in a circuit. Electric currents are measured in Amperes (A). In order for an ammeter to measure a device's current; it must be connected in series to that device. This is necessary because object in series experience the same current. Figure 5.0a and 5.0b shows the picture and circuit diagram of an ammeter.



(a) (b)

Figure: 5.0 Picture and circuit diagram of an ammeter.

Voltmeter (voltage meter) this is a measuring instrument used to measure voltage of any electrical circuit. To measure the voltage across a circuit, voltmeter must be connected in parallel. Figure 6.0a and 6.0b shows the picture and circuit diagram of a voltmeter.



(a) (b)

Figure: 6.0 Picture and circuit diagram of a voltmeter.

Frequency meter: Frequency refers to how many times this AC sine wave repeats per second. The frequency meter is an instrument used to indicate the value of the frequency and ensure that it is appropriate. This will help to know whether the frequency is deviating from the standard value (50Hz) or not. Figure 7.0 below shows the picture of the frequency meter.

Figure 7.0 below shows the picture of the frequency meter.

Contactor (Power Switch): this is a device that allows the activation of load that requires high current and also together or associated with other accessories, contactor can perform the equipment protection function; preventing overload and overheating. Figure 8.0 shows a picture of a Contactor.

Figure 8.0: A Contactor Switch.

Presentation of Results

Current and Voltage characteristics (I-V) Solar PV Trainer

Current and Voltage characteristics is essential in any solar system design. A model or trainer was designed to determine the current and voltage characteristics obtained from the solar energy. Figure 9.0 show the I-V characteristics trainer model.

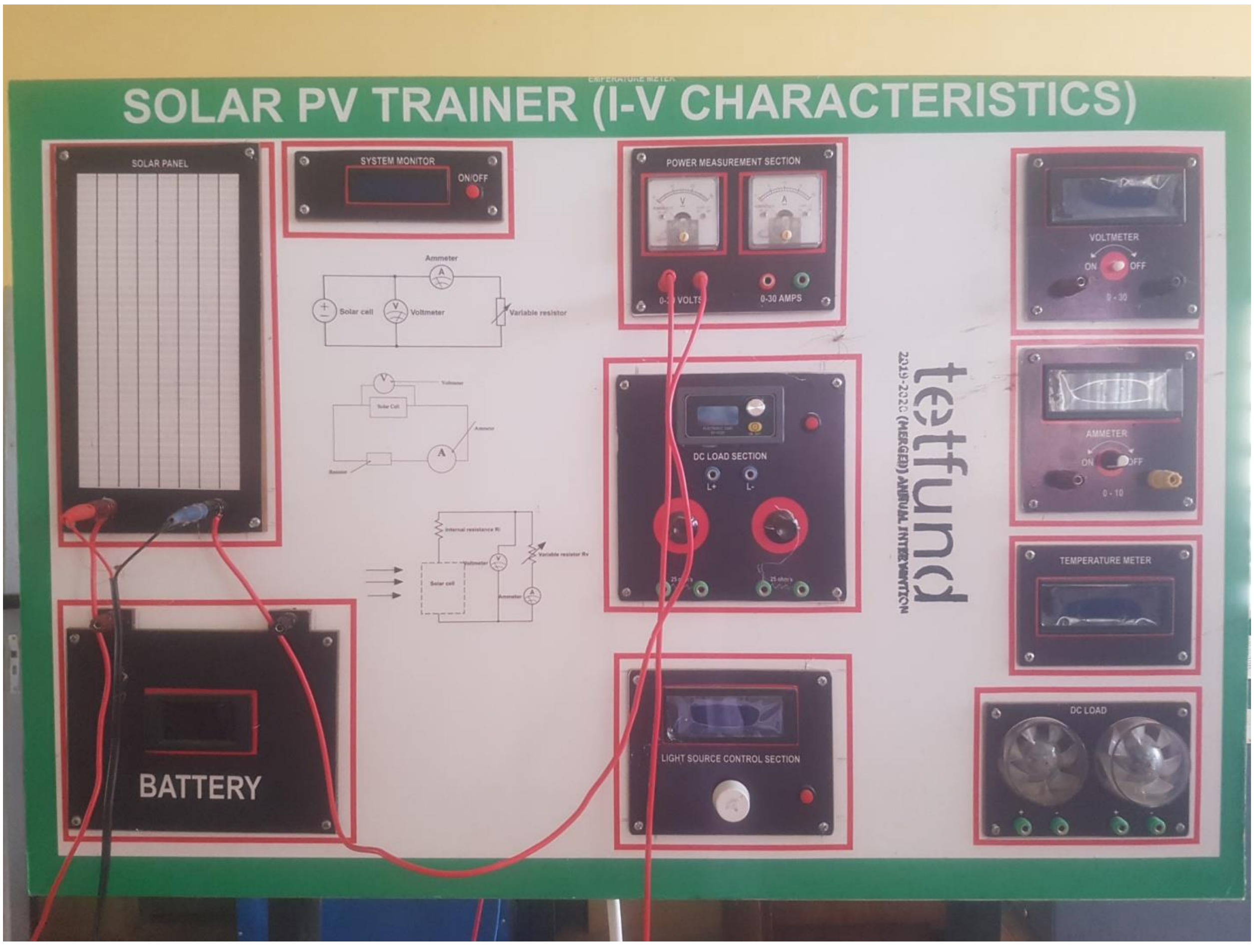


Figure 9.0: the I-V characteristics trainer model

Solar Energy Trainer (Installation Model)

Knowledge of step by step equipment installation is critical in any solar energy system design. Figure 10.0s show the constructed solar energy trainer used to teach student on solar energy installation while figure 10.0b show the complete solar energy system training aids.

Figure 10.0a: Solar Energy Trainer

Figure 10.0b the complete solar energy system training aids

Conclusion
Inadequate supply of electricity in some parts of Nigeria especially the rural areas will affect development and impinge negatively on the economic growth in those areas. Solar energy is the most abundant renewable energy available in Nigeria. It is also a viable tool for solving most of our problems ranging from poor electricity supply to climate change. *It is obvious that in all the six stages involved in establishing solar power plant, namely: site surveying,* solar energy system design, procurement, installation, capability testing and maintenance *all required active involvement of an expert if the system must perform satisfactorily and stand the test of time. A solar energy system training aid and a simulation model was developed and being used to train engineering students of the Federal Polytechnic Ilaro on solar energy system. This series of training will equip students with the requisite skills needed for the design, sizing, modeling, installation and maintenance of solar energy systems.*

Recommendation

The following recommendation ware made at the end of this study;

(i) The TVET institutions in Nigeria should support the hiring of qualified technical personals as well as encourage capacity-building and training initiatives of their staff.
(ii) The government should embrace practical high power generation by expanding the energy sector through the utilization of renewable energy source which includes solar energy.
(iii) To support the growth of Nigeria's engineering and technology, the government should encourage both public and private investors to engage in the building of skills acquisition centers and supporting research projects.

References

Abdullahi, Y. (2023). Buhari Commissions NSIA 10MW Kano Solar Power Plants. Leadership

Addeh, E. (2022). Nigeria's Power Generation cannot support Economic Growth, says Power Minister. ThisDay

Asubiojo L. (2017)."Privatization and Reform in the Global Electricity Supply Industry". *Journal of Energy and Environment. Ann. Rev*., 26(1), 1995, pp. 331 –359

Awosope, C. (2015). "Cost Implications of Electric Power Outages in the University Of Lagos". *The Nigerian Engineer*, 20(1), Pp 48 – 60.

Ekwe O.A. & Ukoima, K.N. (2019) "Review of the Impact of Electricity Supply on Economic Growth: A Nigerian Case Study" *Journal of Electrical and Electronics Engineering (IOSR-JEEE)* Volume 14, Issue 1 PP. 28-34

Energy Information Administration, (2007). "*Annual Energy Review"*. The National Energy Education Development Project, *Intermediate Energy Infobook*, 2007.

Ismaila, H.Z (2017) "Hydro Power Resources in Nigeria" Being a country position paper presented at 2ND Hydro Power for Today Conference International Centre on Small Hydro Power (IC-HP) , Hangzhou, China.

Joshua, O.O., Olayinka, S.O., & Elizabeth, T.O. (2014) "Assessments of Wind-Energy Potential in Selected Sites from Three Geopolitical Zones in Nigeria: Implications for Renewable/Sustainable Rural Electrification". *The Scientific World Journal.* Vol (5),6.

Joy, N. K. (2017). "Evaluating the impact of power pool in selected West African countries for enhanced power supply". Ph.D dissertation. Department of Electrical/Electronic Engineering. Michael Okpara University of Agriculture.

Okafor E.E (2008). Development Crisis of Power Supply and Implications for Industrial Sector in Nigeria. *Stud Tribes Tribals*. 6(2), 2008, 83-92.

Olusola Bamisile, Mustafa Dagbasi, Akinola Babatunde and Oluwaseun Ayodele (2017) "A review of renewable energy potential in Nigeria; solar power development over the years" Engineering and Applied Science Research; 44(4):242-248

Rabiu, A. (2009). "The Cost of Electricity in Nigeria". *International Association for Energy Economics*, First Quarter, 2009, 15 -17.