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Design and Development of Solar System Based Mini-ICT Center for Enhancement of Teaching and Learning in Electrical/Electronic Technology Department, Federal College of Education (Technical), Asaba, Del Ta State, Nigeria.

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ABSTRACT

Design and Development of Solar System Based Mini-ICT Center was embarked upon to enhance teaching and learning in the Department of Electrical/ Electronic Technology, Federal College of Education (Technical), Asaba. The Development of the project was divided into two stages: The Design and the Installation stages. The design stage was carried out to determine the ratings, the quantity and qualities of different components and materials required for the development of the project. Simple design procedures were followed to ensure full compliance with standards. Installation and testing were carried out with guidance from experts, following relevant installation regulations. Results from test carried out show that installation meet the IEEE regulations and the project meet performance standard.

INTRODUCTION

The Information and communication technology (ICT) is an umbrella that includes any communication device or application, encompassing, radio, television, cellular phones, computer, and network hardware and software, satellite system, as well as the various services and applications associated with them, such as video conferencing and distance learning (Adams, 2014). Such technologies are used for educational purposes, namely to support and improve the learning of student and develop learning environments. ICT can be considered as a sub field of educational technology

The importance of information communication technology (ICT) for teaching and learning cannot be overemphasized. One of the reasons the developed world are millions of miles ahead the developing

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countries in educational research and development in the 21st century is because they have been able to integrate ICT into their teaching and learning programs . It is therefore not surprising that during the last covid-19 experience, their educational system did not feel the negative impact it created on the educational system of developing countries. The integration of ICT into our educational system has the potential of not only impacting positively on the teachers and the learners, the assessment procedure can also be improved by it. Some benefits derivable from the use of ICT in teaching and learning activities in any institution include: support for variety of learning strategies, enables choice of learning pace, Support team development in the 21st century, accommodate different learning style, support continuous professional development, providing a variety of resources format, enhancing and extending learning environment, enabling digital collection of evidence and assessing a wide range of skills.

Unfortunately, in spite of these benefits, most tertiary institution in Nigeria still carry out teaching and learning activities in the analogue way .The non-availability of power in some of these institutions has also gone a long way to compound this problem. The objective of this work therefore is to design and develop a solar system based mini-ICT Center specifically for the Department of electrical/ electronic technology and for the College in general.

Statement of the Problem

It is no news today that the future of the countries educational system is hinged on blended learning which involves physical and virtual learning. Virtual or e-learning uses information and communication technology as tools for transmitting, storing, creating, sharing or exchanging data or information (ICDL, 2016). One of the challenges impeding this type of learning in the Department of Electrical /Electronic Technology in Federal College of Education (Technical), Asaba is the non-availability of facilities to carry out this form of learning. Although the school has a center that currently serves the college community, it does not meet the specific need of the Department. This challenge has resulted in the following: Teachers, students are denied the benefit of the use of ICT for teaching and learning, lecturers carry out research with much difficulties, it is difficult to make teaching and learning attractive and interesting to students to mention a few. This project therefore is embarked upon to forestall these lingering challenges in the Department.

Aim of the Project

The main aim of this project is to design and develop a solar system based mini-ICT center that will enhance teaching and learning in the Department of Electrical/Electronic Technology.

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Objectives of the Project: The following are the objectives of the project

I. Design, implement and test a solar power system
II. Identify and procure various equipment required for the ICT center.
III. Install these equipment to meet given specifications
IV. Develop and implement a solar based ICT Center.

Scope of the Design

The center was designed to accommodate a maximum of twenty students

LITERATURE REVIEW

Inverter system Infrastructure: A major part of the ICT center is the solar system. The solar system is an alternative source of electrical power for the center. Without solar system the center cannot be put to optimum use because of the epileptic power in this part of the country. The solar system comprises of the following:

Inverter

This is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC). Inverters are of different types and power ratings . Types of inverters include sine wave, square wave and modified square wave inverters. Power rating ranges from 100W for light load to 30kva for heavy load. A typical solar power inverter system requires a relatively stable DC power source capable of supplying enough current for the intended power demands of the system. The inverter system can be group into the various categories: 12 V, 24, 36 and 48 V, are common standards for home energy systems.

Inverter Output waveform

There are different forms of inverter output waveforms, which include the square wave, modified square wave and the sine wave. Most sensitive equipment can only work when supplied from a sine wave source. The sine wave inverter is more costly to design or purchase.

Household plug-in voltage can be produced from a lower-voltage DC source, then switching boost converter is used to produce a higher-voltage DC before it is converted to AC. The second method converts DC to AC at battery level and uses a line-frequency transformer to create the output voltage.

Inverter Batteries

Batteries convert chemical energy to electrical energy. The inverter battery in the inverter system is the source of energy for the system. They come in different types and capacity. Their capacity is rated in ampere-Hour (AH). Depending on usage, two or more Batteries can be connected together to increase the

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ampere hour rating of the battery. **T**here are two basic ways of achieving this: If the goal is to increase the overall input voltage to the inverter, one can chain batteries in a series configuration. The disadvantage of the series method is that the other batteries will not be able to power the load if any of the batteries has defect. For an increased capacity and prolong runtime of the inverter, batteries can be connected in parallel. This increases the overall ampere-hour (Ah) rating of the battery set. If a single battery is discharged though, the other batteries will then discharge through it. This can lead to rapid discharge of the entire pack, or even an over-current and possible fire. To avoid this, large paralleled batteries may be connected via diodes or intelligent monitoring with automatic switching to isolate an under-voltage battery from the others.

Inverter runtime

Inverters are powered by a single or numbers of batteries joined together in series or parallel called battery bank. The runtime is the time taken for this battery or group of batteries to get drain. Runtime is dependent on the battery power and the amount of power being drawn from the inverter at a given time (Iwayemi, 2013). As the amount of equipment using the inverter increases, the runtime will decrease. In order to prolong the runtime of an inverter, additional batteries can be added to the inverter.

Solar panel

Solar panel is that part of solar power system that attract energy of the sun and convert it to electrical energy through photovoltaic process. They are of different types: monocrystalline, polycrystalline and thin-film solar panel. These different types of solar panels also vary in their construction, cost, and performance. The type of installation determines the type of solar panel to use for that installation. The monocrystalline panels are most efficient (15-22%) whereas polycrystalline (15-17%) is the most cost effective and the thin-film is most suitable for unorthodox roof style.

The cells are connected electrically in series, one to another to the desired voltage, and then in parallel to increase amperage wattage of the module; the manufacturer specifications on solar panels are obtained under standard condition which is not the real operating condition the solar panels are exposed to on the installation site. A PV junction box is attached to the back of the solar panel and functions as its output interface. External connections for most photovoltaic modules use MC4 connectors to facilitate easy weatherproof connections to the rest of the system. A USB power interface can also be used. Electrical connections are made in series to achieve a desired output voltage or in parallel to provide a desired current capability (amperes) of the solar panel or the PV system. The conducting wires that take the current off the modules are sized according to the ampacity and may contain silver, copper or other non-magnetic conductive transition

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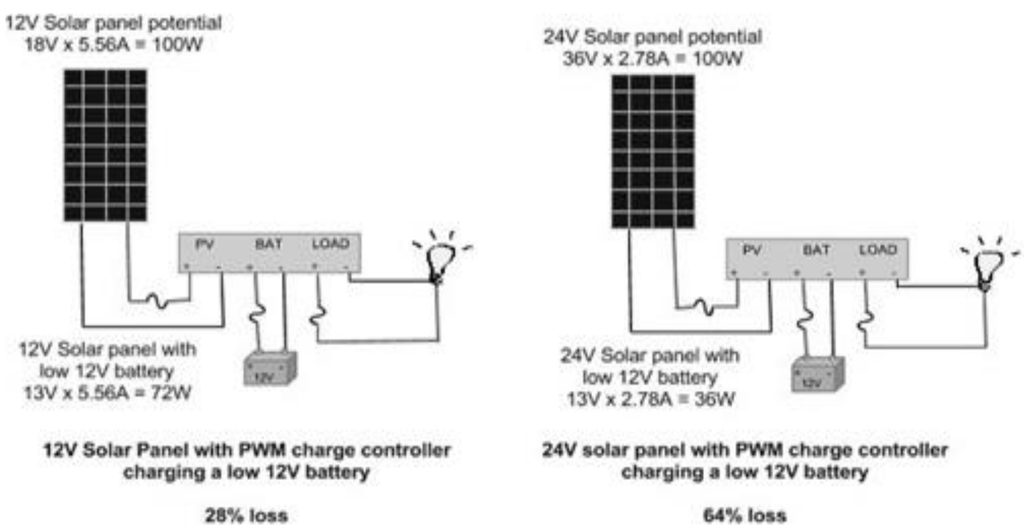
metals. Bypass diodes may be incorporated or used externally, in case of partial module shading, to maximize the output of module sections still illuminated.

Charge Controller

Charge controller is part of solar power system that regulates power from the solar array to the battery bank. It performs many functions, some of which include: Ensures that the battery bank does not get overcharged from the solar array during the day, block reversed current, prevent battery from overcharging, protect from electrical overload and display battery status. The charge controller utilizes two technologies: Pulse width Modulation (PWM) and maximum power point tracking (MPPT)

Pulse Width Modulation". In pulse width modulation technology, the voltage of the battery bank is matched with the voltage of the solar panel. This ensures direct connection between the battery bank and the solar panel. Hence, as the voltage of the solar panel rises, the voltage of the battery bank also rises using more of the solar power as it charges.

Maximum Power Point Tracking". In this technology the PV array voltage can be higher than battery voltage hence it has the ability to provide boost in cold temperature and when the battery is low. Power into the charge controller equals power out of the charge controller, therefore when the voltage is dropped to match the battery bank, the current is raised, so more of the available power from the panel is being used. A higher voltage solar array than battery can be employed



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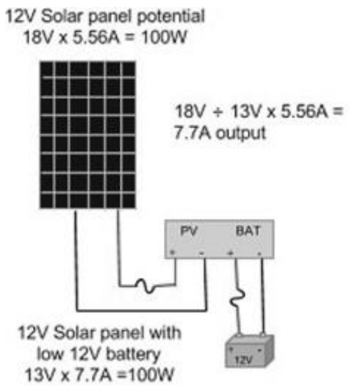
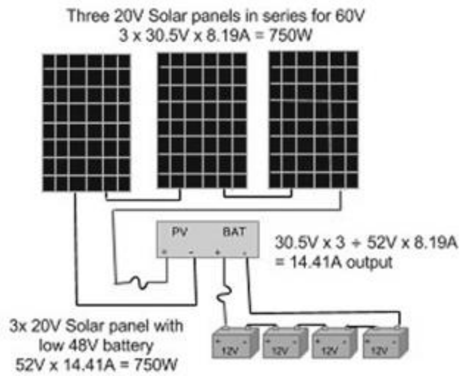


12V Solar Panel with MPPT charge controller charging a low 12V battery

Virtually no loss



Three 20V Solar Panels in series with MPPT charge controller charging a low 48V battery

Virtually no loss

Routers

Router

The router is a piece of network hardware that allows communication between local home networks like personal computers with other connected devices and the internet. It can also be called residential gateway. The router is the first line of security from intrusion into a network. If a higher level of security is desired, a firewall is turned on and that keep the computer system safe from attack. Routers connect modem like fiber cables or DSL modem to other devices to allow communication between those devices and the internet. Most routers including wireless, usually feature several network ports to connect numerous clients to the internet simultaneously

Role of ICT in Teaching /Learning

The Information and communication technology (ICT) is an aspect of technology that comprises any communication device or application, encompassing, radio, television, cellular phones, computer, and network hardware and software, satellite system, including the various services and applications associated with them, such as video conferencing and distance learning (Adams, 2014). These technologies are used for

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educational purposes, some of which include to support and improve the learning of students and develop learning environments. ICT can be considered as part of educational technology. There is no doubt that ICT has brought massive changes in the field of education. It makes teaching- learning process effective and interesting. In educational system, the inputs are teachers, students, classroom materials, equipment of teaching, methods of teaching and the outputs are quantity as well as quality of students learning. The effective integration of ICT with teaching/ learning environment increases the chance of gaining education along with increased productivity, (Chendu, 2002). Information communication technologies are influencing all aspects of life including education. They are promoting changes in working conditions, handling and exchanging of information, teaching-learning approaches and so on. ICT is becoming a game changer in the teaching approaches and the ways students are learning. ICT-enhanced learning environment facilitates, active collaborative, creativity, integration, and evaluative learning as an advantage over the traditional method (Ajayi, 2007). In addition, the major areas of focus of ICTs use in education systems of developing countries includes training teachers in new skills and introducing innovative pedagogies into the classrooms, investing on ICT infrastructure for schools and creating networks among educational institutes, improving overall standard of education by reducing the gap in quality of education between schools in urban and rural areas, initiation of smart school with objectives to foster self-paced, self-assessed, and self-directed learning through the applications of ICTs, and developing ICT policy for Education and Training

METHODOLOGY

The development of this work was carried out in the following order:

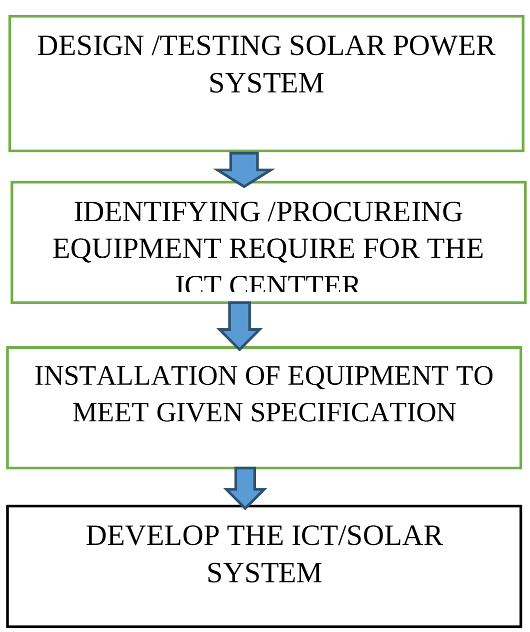

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Figure 3.1: Design Structure

System Design

Figure 3.2 shows the various block that makes up the ICT Center.

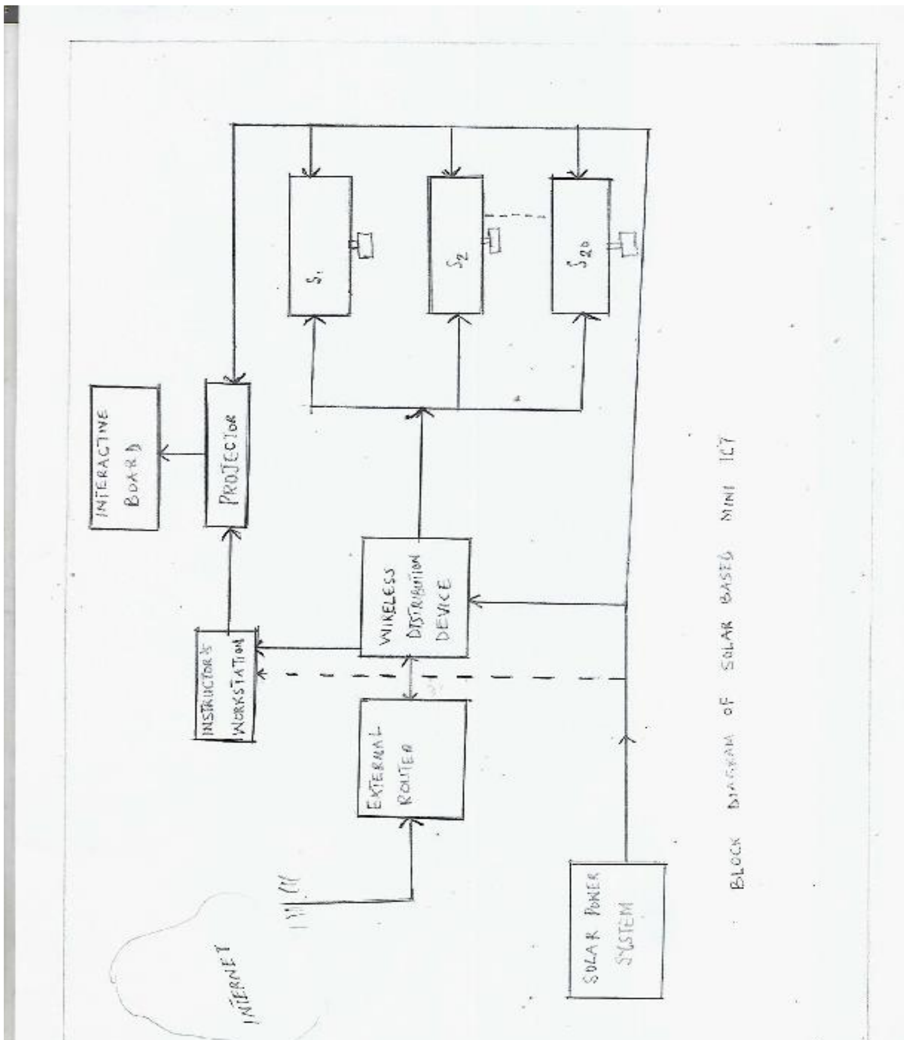

Figure 3.2: Block Diagram of the ICT Center

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Table 2: ICT Materials /Specifications

S/N	Components	Specification / No
1	Router	2Mbps / 2
2	Inverter	3kva / 1
3	Battery	200AH / 2
4	Charge Controller	MPPT 24V / 1
5	Solar Panel	300W, 12V / 4
6	Connecting Cables	$4mm^2$ Cables, Flexible Cables, Jumpers and connectors and cable Accessories
7	Tables	Table
8	Chairs	Armless Chair
9	Changeover switch	100Amps
10	Interactive Board	
11	Projector	
12	Laptop Computers	

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13	Desktop Computers	

SOLAR SYSTEM DESIGN

The system was designed for twenty Electrical/ Electronic students. The following Equipment and materials were used for the design of the System:

Desktop computers, Laptop computers, Server, Routers, Projector, Interactive board, Tables/Chairs, Batteries, solar charge controller, assorted connecting cables, solar panels and other relevant electrical accessories and tools. The block diagram of the system given in figure 3.3

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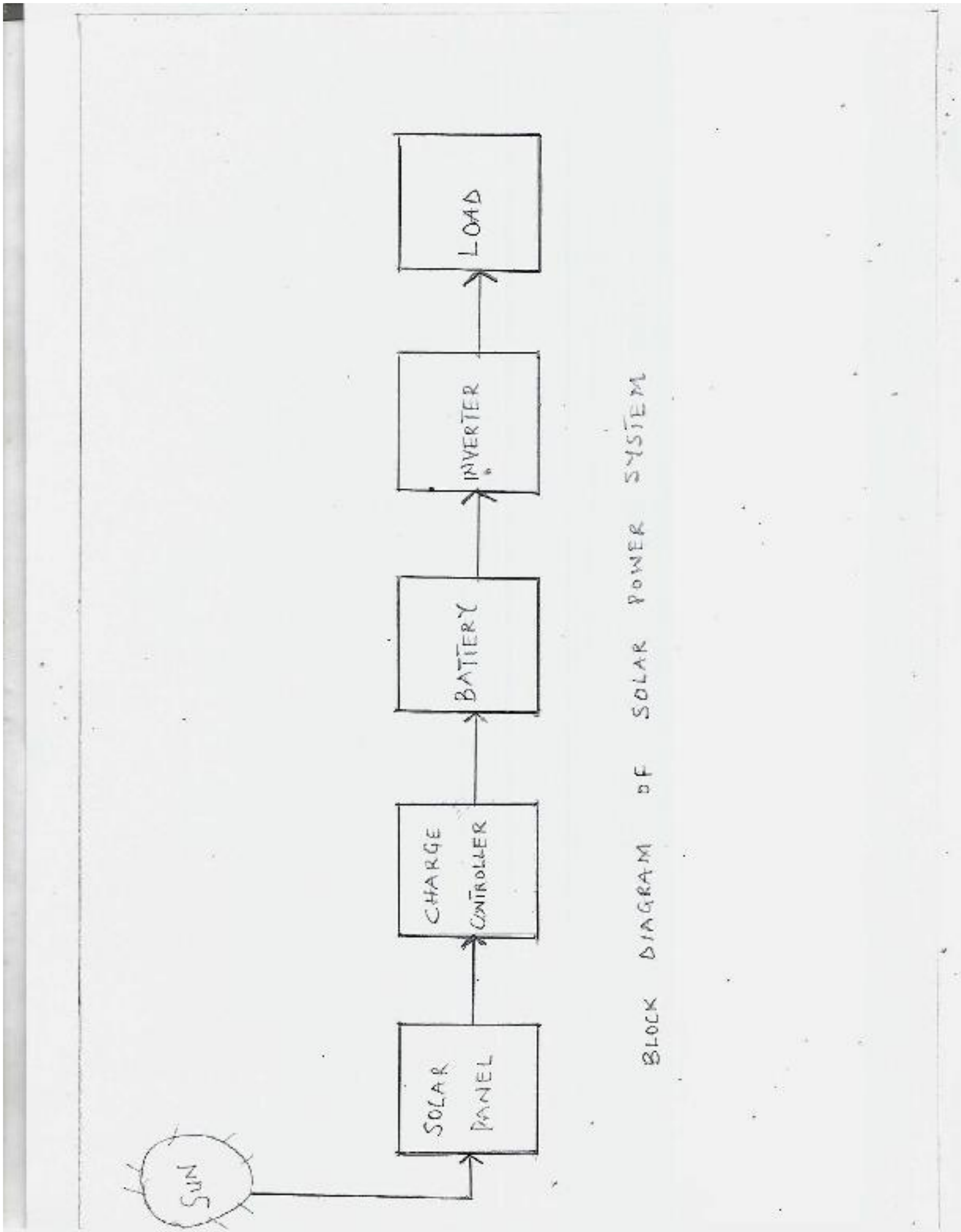

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Block Diagram of Solar system.

Design of internet system

In order to provide internet services to the center, installation was carried out in the following procedure:

1. Have an agreement with an internet service provider (ISP) – MTN and GLO network was chosen to forestall failure by any of the network
2. The Router was connected to the wall bracket via a coaxial cable
3. The ethernet cable was inserted into the WAN/ Uplink port on the router.
4. The opposite end of the cable was inserted into the router ethernet port.
5. Wi-Fi setting was connected to the wireless network after entering the network key to start using the network.
6. The power supply plug was connected and waited for the power light on the Router and modem to turn on

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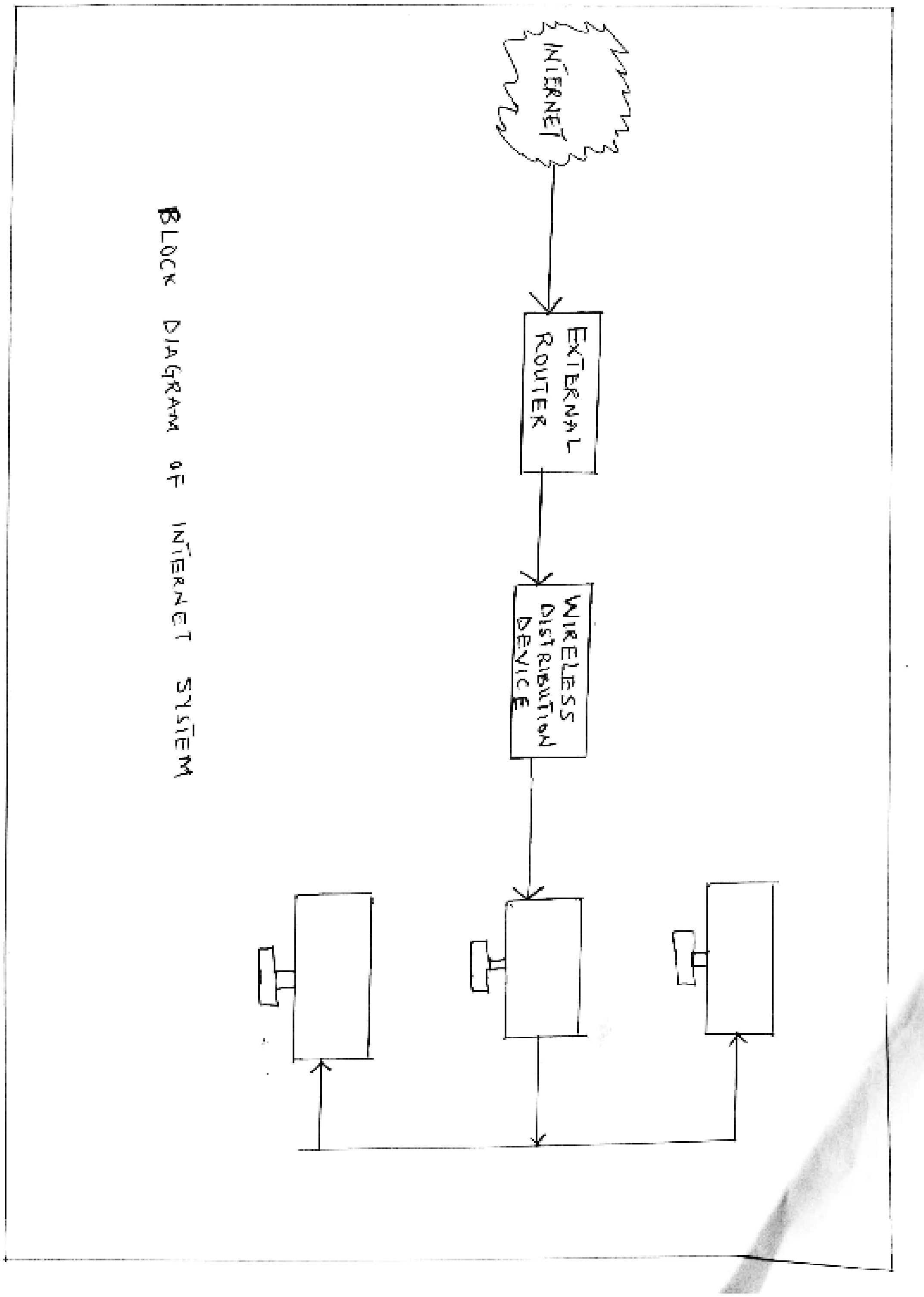

CamScanner

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Block Diagram of internet System

LOAD CALCULATIONS

S/N	LOAD TYPE	LOAD NO	LOAD VOLTAGE	WATTAGE	TOTAL WATTAGE	CURRENT VALUE
1	Desktop computer	10 PCS	240V A.C	85W	850W	3.54A, A, C
2	Laptop Computer	10Pces	240 V	65W	650W	2.7A
3	D.C Electric Bulb	10 PCS	12V	2W	20W	1.7A D.C
4	Electric Fans	7PCS	240V	20W	140W	0.58A, A.C
5	Projector	1	240V	20W	20W	0.08A, A.C
6	CCTV Cameras	A set of 4 PCS	240V	5W	20W	0.08A, A.C
7	Total				830W,240VA.C. 20W, 12V DC	6.98A, A.C 0.6A D.C

The solar system is expected to be functional 24 hours a day.

Required Material Specifications

S/N	MATERIALS	SPECIFICATION
1	Solar Panels	4No 150W Solar Panel connected in parallel
2	Charge Controller	20W, 12V MPPT Charge Controller
3	Batteries	2No 250AH Inverter Batteries Connected in Parallel
4	Inverter	1.5KVA inverter

The layout of the ICT center is shown in figure below

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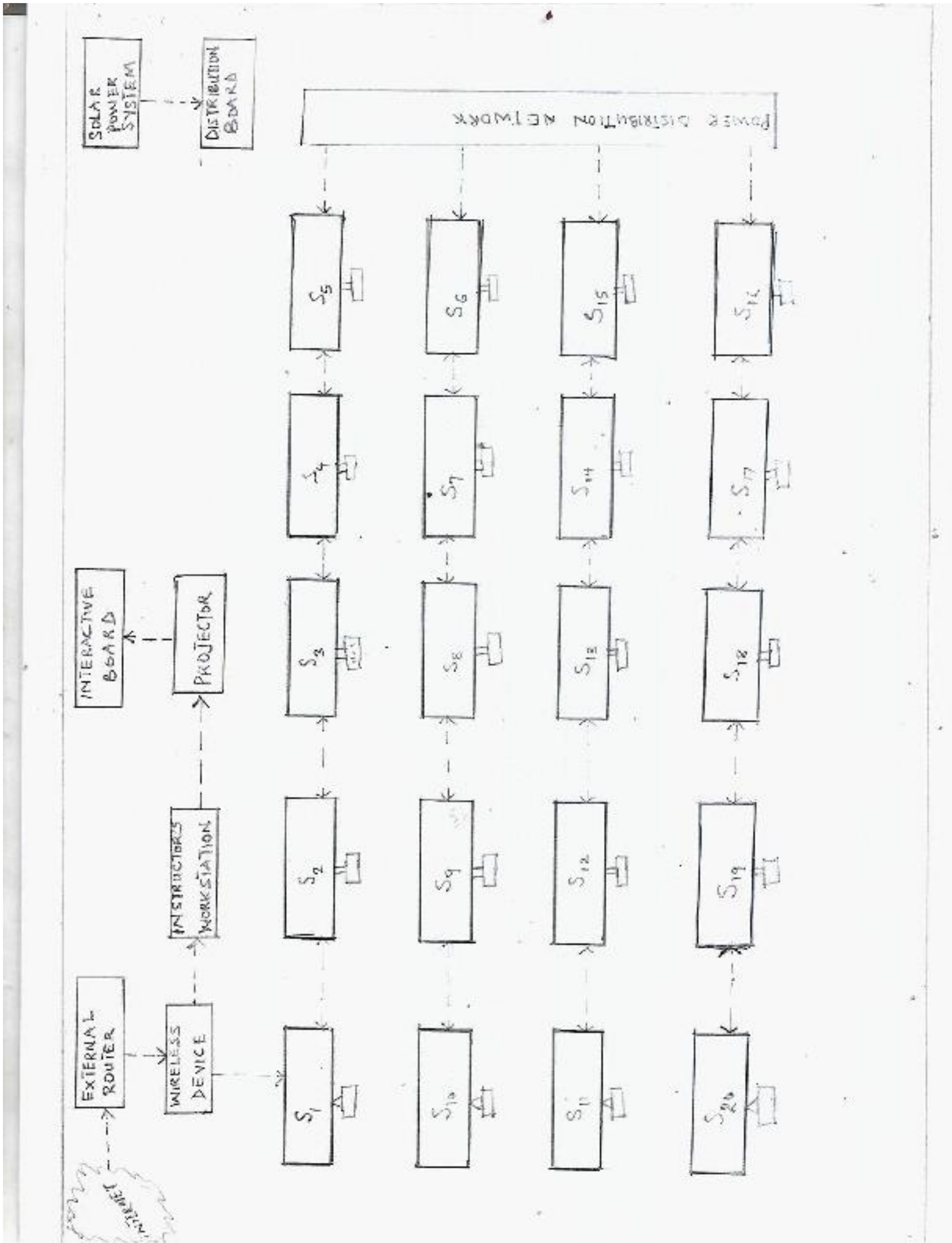

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Testing/ Result

The following tests were carried out on the installation:

Insulation Resistance Test, Continuity test, Voltage Test, Current Test, Resistance Test and polarity test

	Test Type	Procedure	Instrument	Result	Remarks
1	Insulation Resistance	This was carried out on cables to determine the insulation resistance between cable conductor and insulator	Insulation Resistance Tester	Resistance Value ➢ 1MΩ	Result Satisfactory
2	Continuity	Continuity test was carried out on the cables to find out if there is an open circuit on cable conductors	AVO Meter (Resistance Range)	Resistance Value < 0.1Ω	Result Satisfactory
3	Voltage Test	1 DC voltage test was carried out to confirm the voltages of the batteries, Charge Controllers and solar Panels 2 AC Voltage Test was use to check the Voltage output of the Inverter	AVO Meter (DC voltage Range)	Each Battery DC voltage was 13.5 V DC	Result Satisfactory
4	Current Test	Amperage meter was used to test the current flowing between solar panel and charge Controller and between charge controller and the	Ampere Meter	1.5 to 2.5Amps	Result Satisfactory

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		batteries			
5	Resistance Test	Resistance test was carried out to test the resistances of	AVO Meter (Resistance Range)		Result Satisfactory
6	Polarity Test	Polarity test was carried out to ensure that switches, fuses were connected to live conductor and live part of socket outlets. Whereas neutral and earth were connected to neutral and earthed terminal respectively	AVO Meter (Continuity Range)	Beaming sound	Result Satisfactory

Identifying /Procuring Equipment

A lot of effort was put in to identify relevant materials and equipment required to develop this center. Experts in various relevant field were consulted to ensure that we were able to meet the given specifications for this project. Market survey was done, we compared prices of equipment from their various manufacturers to ensure that the best equipment/ materials were procured at minimum cost.

Equipment Installation: Installation was carried out with relevant tools by both students of the Department with the assistance of experts in the field. This is to afford students the benefit of learning the technicalities involve in the installation and to minimize cost of installation. Figure 4 shows the layout diagram of all the equipment for the center.

CONCLUSION

The design and development of solar system based mini-ICT center for Electrical/Electronic Technology Department was carried out to improve teaching and learning in the department and also to make research work easy and interesting for lecturers in the department. The solar system is expected to provide twenty-four hours services. Lecturers and students who may wish to work at night will not have problem doing so. The ICT system is configured to provide utmost services throughout the day.

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