Electricity Provision In Nigerian University Libraries: The Solar Energy Solution

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Abstract: The library is widely accepted as the heartbeat of the educational enterprise. Improving the quality of library services in higher education systems via solar energy back-up becomes necessary as a result of the inadequacy of power generation and distribution in Nigeria. The Nigeria's power generation capacity is 6,090MW (Estimated demand is 10,000MW); yet actual supply fluctuates well below that figure and averages less than 50 percent of its capacity annually. According to Energy Information Administration (EIA), Nigeria has one of the lowest rates of net electricity generation per capita in the world. The Country's generation is often hampered by gas supply challenges caused by pipeline vandalism along its Escravos-Lagos pipeline network, among other issues. Policy framework exists to increase generation to over 20,000MW by 2020. Obviously, there is much work to be done. Should the universities wait? How long? Solar energy is the solution to the problem.

Index Terms: Electricity provision, University libraries, solar energy, Nigeria

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1.0 Introduction

1.1 Background of the Review

The generation of electrical power is one of the most important applications of solar energy. In this system, generally the solar energy is converted into thermal or heat energy. Here the heat can be converted directly into electrical energy by solar cells. In recent years, the developing countries of the world especially in Africa have experienced what is often called "energy crises" with regard to incessant power outages. A crisis is a turning point in the course of history, and recent developments clearly fit into this description. Energy is a commodity and it is, therefore, available to users who are willing to pay whatever price the sellers ask for it. The relevant questions are how much energy will be demanded at a given price at a particular time? How much can the energy suppliers afford to spend to provide the energy? At some points, the answers to these questions match and the markets forces of demand and supply converge. This economic action is altered by regulatory and other government controls. For years now, we have witnessed a period of rising prices and uncertain political influences on fuel supply. Each of these factors constitutes an important element of change. Food and fuel (exclusive of nuclear energy) have been made possible by the sun through the photosynthetic combination of water and atmospheric carbon dioxide in growing plants. Energy from the sun is the basic energy support for life and underlies the wind, the climate and fossil fuels. The interest of this work is for the direct use of the sun's energy as it impinges on the earth by tapping the energy in the form of electromagnetic energy prior to its conversion to wind energy, fossil fuel, plants, and most importantly, to electricity.

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1.2 Brief Historical Development of Solar Energy

The history of photovoltaic energy (aka. solar cells) started way back in 1876. With the recent rise in energy costs many people have been looking to alternative sources of energy. One of the greatest energy sources (our sun) is readily available for the taking. We just need to be able to harness its power. Below is a brief history of how solar power came to be (**Reese (2015).** The history of photovoltaic energy (aka. solar cells) started way back in 1876. William Grylls Adams along with a student of his, Richard Day, discovered that when selenium was exposed to light, it produced electricity. An electricity expert, Werner von Siemens, stated that the discovery was "scientifically of the most far-reaching importance". The selenium cells were not efficient, but it was proved that light, without heat or moving parts, could be converted into electricity. In 1953, Calvin Fuller, Gerald Pearson, and Daryl Chapin, discovered the silicon solar cell. This cell actually produced enough electricity and was efficient enough to run small electrical devices. The New York Times stated that this discovery was "the beginning of a new era, leading eventually to the realization of harnessing the almost limitless energy of the sun for the uses of civilization." The year is 1956, and the first solar cells are available commercially. The cost however is far from the reach of everyday people. At $300 for a 1 watt solar cell, the expense was far beyond anyone's means. 1956 started showing us the first solar cells used in toys and radios. These novelty items were the first item to have solar cells available to consumers. In the late 1950's and early 1960's satellites in the USA's and Soviet's space program were powered by solar cells and in the late 1960's solar power was basically the standard for powering space bound satellites. In the early 1970's a way to lower cost of solar cells was discovered. This brought the price down from $100 per watt to around $20 per watt. This research was spearheaded by Exxon. Most off-shore oil rigs used the solar cells to power the waning lights on the top of the rigs. The period from the 1970's to the 1990's saw quite a change in the usage of solar cells. They began showing up on railroad crossings, in remote places to power homes, Australia used solar cells in their microwave towers to expand their telecommunication capabilities. Even desert regions saw solar power bring water to the soil where line fed power was not an option! Today we see solar cells in a wide variety of places. You may see solar powered cars. There is even a solar powered aircraft that has flown higher than any other aircraft with the exception of the Blackbird. With the cost of solar cells well within everyone's budget, solar power has never looked so tempting. Recently new technology has given us screen printed solar cells, and a solar fabric that can be used to side a house, even solar shingles that install on our roofs. International markets have opened up and solar panel manufacturers are now playing a key role in the solar power industry. Solar radiation has been used by man since the beginning of time for heating his domicile, for agriculture and for personal comfort. Solar heating has been utilized in various forms since ancient times, when the sun's rays were focused for heating and cooling. According to Dorf (1978), Joseph Priestly in 1774 in the desert of North Chile, built a solar distillation unit covering 4, 750 square metres of land to provide fresh water from salt water. He stated further that at an exhibition in Paris in 1878, sunlight was focused on a steam boiler that operated an engine which drove a printing press. During the period 1901 to 1915, several solar collectors used with steam engines of several horsepower were constructed in California and Pennsylvania in the United States. Furthermore, Phillips (1992) asserted that the conversion of solar energy to electricity was first accomplished with a "Solar Cell" of semi-conductor material in 1954 at the Bell Laboratories in the United States. He also stated that although it was of low efficiency, the cell's applicability was demonstrated a year later with an array generating 9 watts of power which was used to operate a telephone repeater and that this success led to an extensive application of solar cells to spacecraft, starting with National Aeronautic Space Agency (NASA) satellite vanguard I in 1958. More recently as reported by Momah (1999), solar energy has been used to power a village in Enugu State and the same is true of the three Brigades of 1 Mechanized Division in Kaduna - all in Nigeria. Indeed, the utilization of the sun's energy seems promising.

2.0 LITERATURE

2.1 Reports on Electricity Situation in Nigeria

The Nigerian power sector has been in crisis for many years. Much of the generation, transmission and distribution capacity has become worn out or damaged. Nigeria is the world's 5th largest oil producer. According to Adam Smith International (2015) in Nigeria, the average annual per capita power consumption, only 155 kWh, is among the lowest in the world and Nigeria's per capita electricity consumption is 7% of Brazil's and 3% of South Africa's. At the same time, at least 50% of Nigerian households have no connection whatsoever to the grid. Self-generation (diesel or petrol generators) in Nigeria is estimated to be 6,000MW.For Nigerians and for the Nigerian economy, the price to pay for this is crippling. The poor currently pay more than N80 (£0.32)/kWh burning candles and kerosene, whereas manufacturers pay in excess of N60 (£0.24)/kWh on diesel generation. Meanwhile, everyone else who can afford it pays around N50-70 (£0.20-0.28)/kWh for self-generation. By contrast, grid power, if available, costs between 18 and 23/kWh. Absence of adequate power is the most significant barrier to economic growth in Nigeria. If the current power situation continues as it is until 2020, the Nigerian government estimates that some $130bn (US dollars) (£81b) in GDP would be lost every year. Ossai-Ugbah (2012) lamented the sorry state of power generation and reported that installed capacity is 8,000MW, but only 4,000MW is operable of which only about 1,500MW is available to generate electricity. At 125kWh per capita, electricity consumption in Nigeria is one of the lowest in the world.Of course the 4,000MW now being generated for Nigeria's population of 150 million is still far too low. In contrast, Brazil generates 100,000MW of grid-based power for 201 million and South Africa generates 40,000MW for 50 million (**Adam Smith International, 2015).** Business Day Research and Intelligence Unit (BRIU) concluded a survey to evaluate the state of the Power sector in Nigeria and its impact on Nigerians. As reported by Omomia (2015) the sample size was taken from Lagos State, the commercial nerve centre of Nigeria, home to several manufacturing firms, multinational companies, financial institutions, SMEs and other businesses. However, the focus of this survey was on the residential consumers of electricity in Lagos. The sample size cut across all areas and sections of the state comprising Lekki, Magodo, Ilupeju, Badagry, Apapa, Surulere, Ogba and Agbara. Subsequently, BRIU covered various locations and local government areas in Lagos. Unsurprisingly, when asked their views on the current state of power supply based on personal experience, the respondents are very dissatisfied. Analysis among the respondents revealed that only 1.3 percent are very satisfied with the level of electricity provided; 7.5 percent are somewhat satisfied; 3.8 percent are neither satisfied nor dissatisfied; 8.8 percent are somewhat dissatisfied while the balance of 78.8 percent are very dissatisfied. Furthermore, the respondents also had similar views and experience not just with the power generation segment but also with the distribution sub-sector, as 70% of residential customers are very dissatisfied with the services of their distribution companies, otherwise referred to as DISCOs. In addition, 12.5 percent are somewhat dissatisfied while 8.8 percent are neither satisfied nor dissatisfied and the balance of 8.8 percent is somewhat satisfied. The Eko and Ikeja Distribution Companies are responsible for the receipt of electricity from the generating companies also known as GENCOs and subsequent distribution to the electricity consumers in Lagos state. Overall, the DISCO segment of the electricity industry have decried the dilapidated distribution infrastructure across the country as a limiting factor in meeting expected capacity to supply power to consumers (Omomia ,2015). However, we expect that there should have been some noticeable investment in the distribution infrastructure in the sector now that it has been transferred to private owners. Sub Saharan Africa is underpowered and facing a crisis of low electrification and generation at a combined capacity of 68 megawatts spread across 48 countries (Eberhard, A., Fioster, V., Bricefioi0-Garmendia, C., Ouederaogo, F., Camos, D. & Shkaratan, M., 2008). According to a report published by the African Development Bank Group (2009), the gap in the power sector indeed has far reaching implications for improving the business climate, sustaining economic growth and the social wellbeing of Nigerians; about 45% of the population have access to electricity, with only about 30% of their demand for power being met; that the power sector is plagued by recurrent outages to the extent that some 90% of industrial customers and a significant number of residential and other non-residential customers provide their own power at a huge cost to themselves and to the Nigerian economy. According to Amadi (2011) Nigeria with a population of 150 million people generates 3,600 megawatts on the average "from a generation capacity of 5.96gw." However, the average period Nigerians experience outage is about 40 times a month (Amadi, 2011). This current abysmal state of low level generation, distribution and electrification has led to various efforts to intervene in the power sector to arrest the situation. Such measures include the electric power reform act. This is because about 70% of Nigerians have no access to power and generation hovering around 3,200 megawatts (Onogoruwa, 2011). The low level electrification has affected several areas of Nigeria's life. The power state of electricity supply is attributed to constitute 70% of problems for mobile telephone operators (Opara, 2011, Uzor, 2011). Similarly, companies attest to spending 40% of their overheads on generators (Alawiye, 2011). Thus, Nigeria and Nigerians including the academic community are paying more for darkness as most cities are overrun by darkness.

2.2 Running Library Services on Generators

University libraries in Nigeria have long realized the need to run effective systems and integrated services for her immediate community. Since the university community is not removed from the larger society, it also suffers from the economic and social effects of power outages like other sectors of the nation. Delta State University, Abraka spent 13 million naira monthly on one campus running it on generators (Arubayi, 2011). Outages portend negative cost for the academic community and the University of Benin is not left out. A breakdown of cost implication of running library services on generators in the University of Benin, Benin City over a five school sessions (2006/2007 – 2010/2011) is given below (John Harris library management records), 2006/2007 – 2010/2011.

Table 1: Cost of Running Library Services on Generators in John Harris Library

Academic session	Amount expended on Diesel in Naira
2006/2007 session	N83,064,128.00(eighty three million. Sixty four thousand, one hundred and twenty eight naira)
2007/2008 session	N126,864,599.00 (one hundred and twenty six million, eight hundred and sixty four thousand, five hundred and ninety nine naira)
2008/2009 session	159,040,923.00 (one hundred and forty nine million, four hundred and twenty one thousand, two hundred and seventy three naira)
2009./2010 session	N149,421,273.00 (one hundred and forty nine million, four hundred and twenty one thousand, two hundred and seventy three naira)
2010/2011 session	N140,550,850.00 (one hundred and forty million, five hundred and fifty thousand, eight hundred and fifty naira.

Source: Ossai-Ugbah (2012). Delta Library Journal

2.3 Solar Back-Up System

Information Technology (IT), according to Daniel (2002) can be described as the main grand hero of this century. Driven by extreme courage and unlimited ambition, it replicates itself, sweeping and overshadowing everything on its path. Incidentally, as IT is not passive, it impacts very noticeably on everything it touches, marginalizing anyone who refutes its supremacy. In the global village setting of today, developing countries of the world especially in Africa cannot but accommodate this IT invasion, as they must cope with its inundation and exploit its several possibilities maximally for the betterment of individual human beings, the library profession and the development of various countries in this knowledge age. The question now is, how can IT be exploited to the maximum when there are energy crises in terms of provision of electric power in the developing parts of the world? IT is synonymous with electricity generation and this is the sole reason why the introduction of information technology must not be treated in isolation. As stated earlier, an abundant and inexpensive supply of energy is one of the critical requirements for economic development. Throughout history, the questions of wealth, equality, independence, survival and ruin of human society depended on whether or not man had access to energy. Hence, Gbadegesin (1995) stated that although the fossil fuels which include crude oil were the traditional sources of industrial power, by far the largest and most reliable source of energy on the earth's surface was solar radiation provided by the solar system. He went further to say that solar energy was an important resource in Africa but that its potentials were yet to be fully developed. For example, Nigeria has mean annual hours of about 3,300 in the northern parts of the country. This means that solar recipients throughout the country are enormous even though these have been hardly harnessed for domestic or industrial use.

2.4 Other Uses of Solar Energy

The various uses to which solar energy could be put are:

- Drying crops such as cocoa and pepper;
- Operating machines that fetch water from underground water sources for irrigation purposes in the semi-arid zones and for drinking;
- House-hold heating purposes, air conditioning and charging storage battery; and
- Most importantly, generation of electricity.

According to Singh (2007) the following are the main applications of solar photovoltaic systems:

- Irrigation water pumping.
- Railway signaling equipment.
- Battery charging.
- Street lighting.
- Weather monitoring.
- Community radio and television sets.

2.5 Advantages of Photovoltaic Solar Energy Connection

Furthermore, singh identified the following as the advantages of using

1. Conversion of light to electricity through solid state device.
2. Cost of maintenance is low.
3. Easy to operate.
4. No supervision is required for a longer period.
5. They are free from pollution.
6. They have longer life.
7. They are more reliable.
8. Because the sun's energy is free they consume no fuel in their operation.
9. They are easy to fabricate being simplest semiconductor device. The main disadvantage is high initial cost.

The library is widely accepted as the heartbeat of the educational enterprise. Improving the quality of libraries in higher education systems via solar energy back-up will no doubt, translate to improving the quality of products of the system. The development of uninterrupted power supply will be a great relief and challenge to librarians and indeed the entire staff of the library. This is because library processes and services can go on uninterrupted by one of the greatest threats to information and communication technology-power outages. Akintunde (2002) asserted that the installation and activation of the 800 watts solar electric power back-up system in the University of Jos, Nigeria main library in February 2002 was certainly a great challenge to both staff and students. It is not only a challenge to the staff and students of the University of Jos, it is also a challenge to other university libraries in developing countries of the world, which have been experiencing incessant power outages. The true meaning of interactive learning (learning using multimedia) is exploration, where individuals would browse, discover, hypothesize, problem-solving and generally engage in what Njoku, (2002) quoting Mayes, Kibby and Anderson (1990) described as “effort after understanding”. The interactivity in education and learning techniques brought about by the new technology transformed the relationship between teachers and learners and hence their needs for libraries and librarians as we knew them yesterday. This has become necessary considering the fact that today library users as learners have unlimited access to cruise the electronic super highway, in a menu-fed interactive mode seeking for and at the same time contributing information by surfing the web, creating web-sites and web banks which now form the domain for the new age virtual library. Library users are no longer mere consumers of library services. Today, they want access which will no longer be limited by time and space. As asserted by Chukwusa (2008) the knowledge base which library users want to access is no longer stored in linear media such as textbook and other items that are paper-based but rather in a computerized electronic information domain. Therefore, as we strive to join the information super highway through the introduction of information technologies in university libraries, we must brace up to the new challenge posed by this innovation.

2.6 The Way Forward.

Chukwusa (2008) reported that the inability of developing countries to provide communication as it affects data transfer has caused a setback in modem library development. With the introduction of information technology and the subsequent advent of electronic mailing system, exchange of information can only follow modem information transfer systems such as the Internet.

Finance is the life-wire of any organization and the library is no exception. Information technology is not cheap. Good funding is imperative to sustain an uninterrupted and qualitative flow of information. Experience has shown that automation becomes costly when it fails to deliver as expected (Momah, 1990). The mistakes of the past should teach Africans to do things right the first time. This principle of quality dictates that it is cost-effective to pursue excellence. It cannot be business as usual. Africa must innovate, plan, build and maintain in order to sustain any good automation project. Government, as a matter of urgency, should make budgetary provision for the installation of solar back-up systems for academic and research libraries. The now withdrawn 10% of the recurrent grant for university libraries was not enough to meet their needs in terms of developing their collections let alone installation of a back-up system. It is on the basis of this that Opeke (2002) suggested that inter-governmental organizations like UNESCO and local non-governmental organizations (NGOs) should play supplementary roles towards that effort, but government needs to provide the leadership. According to Opeke (2002), many developing countries of the world have no place for information-related issues and there is no known national information policy, let alone informatics policy. Opeke (2002) also quoting UNIDO (1995) defined informatics as the field of investigation which takes as its subject matter the variety of ways in which information flows and the manner in which information is processed and utilized. These affect productivity and efficiency. Since they are used for monitoring and control purposes, they influence socio-economic development. As reported in Nigerian Tribune (2004), Nigeria only recently instituted ICT committee in July, 2003 with the task of formulating a national ICT strategic action plan which is vital for the effective implementation of a national IT policy. If Nigeria is lacking in this respect, many other African nations could be in this predicament. Fortunately, a national ICT policy was formulated and published in 2004. But an information policy is still hanging in the air. In the same vein, Okiy (2004) enumerated the problems besetting the introduction of ICT in academic libraries to include funding, epileptic power supply, acute shortage of competent manpower for information technology operation and maintenance and lukewarm attitude of government towards the development of ICT facilities.

3.0 CONCLUSION

Technology is the language of the future and science is its grammar. Therefore, only those who can speak the language will be relevant in the 21 century and beyond. Those who are not will be swept into the dustbin of history. Hence, the onus lies on the university authorities and government to make hay while the sun shines by investing wisely. The potentials for developing solar powered electricity seem very great, though at present there is the need for recognition of its value by government (Chukwusa, 2008). Developing countries of the world seem too petrified to take the first giant step towards sustainable technological development. What then is that first giant step? It is simple: putting ICT in place and effectively implementing National Science and Technology Policy. Failure to do so will be their undoing and this lapse will continue to widen the gap between developing and the developed countries (Momah 1999). The solution to the prevailing problems depends on how developing nations plan their tomorrow today and how best they evolve and practice the right policy.

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