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Awareness and Use of Solar Energy as Alternative Power Source for ICT Facilities in Kogi State, Nigeria

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Abstract

One of the major hindrances to the penetration of information and communication technology (ICT) devices in underserved and unnerved areas in the developing nations is the absence and inadequacy of electricity to power technological devices. Inadequate supply from the national grid, land and water pollution from oil spillage in the oil producing communities among other factors have led Nigeria and indeed the world to look for alternative power supply such as solar energy. Unfortunately, utilization and development of solar energy is rising in other parts of the world but encountered with low pace of development and utilization in Kogi State. This paper reports a survey carried out to investigate the awareness and use of solar energy as alternative power source for ICT facilities in Kogi State. Descriptive research design using survey method was adopted for this study. Questionnaire was designed and used as survey instrument. The population for this study. This study finds that all the respondents have good knowledge of what solar energy is Majority of the respondents have experienced solar energy as alternative power source for ICT before. They have also read and heard about solar energy as alternative power source. They were therefore well informed about solar energy equipment as majority of them have alternative power source (mostly power generating sets) in the State. They were also aware that solar energy can power their ICT equipment as they also believe that using solar energy, erratic power supply can be mitigated to a large extent. Conclusions were drawn based on the findings of the study and recommendations offered.

Keywords: Solar Energy, Alternative Power Source, ICT Facilities, Kogi State, Nigeria

Introduction

Power supply is one of the major problems many developing nations of the world have faced in the recent years. This has been exacerbated because of population explosion and the economic pressure to generate more power supply to meet the domestic, social and economic needs of the nation. In response to lower energy prices and reinvigorated economic growth, demand for all forms of energy is increasing steadily. With the growing realization that man's resources, to a great extent, are not natural resources but the result of human ingenuity aided by knowledge and experience, it

would appear that the only barriers to unlimited growth of the world's energy supply are political and economic.

Energy resources, supply and utilization play a significant role in the economy of each developed and developing country in the world. This was particularly evident during the world oil crisis, when the Western world could no longer get oil at cheap prices. Energy technology programs aimed at reducing dependence on imported oil sources, developing indigenous resources, promoting energy conservation and harnessing renewable sources flourished from that time. These programs continue in importance and have been refined in each of the developed nations. The agencies that direct the programs are now well established and publication and promotion of the knowledge gained is an important function. Within each nation are government agencies that have particular responsibility for energy, its policy, economics and technological development (Brookes, 2008).

A mounting international trade predicted upon the laissez-faire economics of the early political arithmeticians has greatly improved the availability of all forms of energy and in recent times has been responsible for undoing a considerable amount of the damage done by skyrocketing oil prices. The more afflicted by industrial economics have made great strides in setting their energy priorities in order, and conservation, in its many forms, has become an overriding cost consideration.

The world, like the domestic economics that comprise it, is afflicted by misdistribution of income, population, and energy. For example, the United States, Canada, Australia, Western Europe, and Japan - all industrialized and affluent nations, account for only 16 percent of the world's population but consume 50 percent of total energy, and as a consequence generate 66 percent of global income. In contrast, the 100 or more non-industrialized nations contain 50 percent of the global population, consume 16 percent of world energy demand, and produce roughly 16 percent of global income (Duffie, 2008). Certain unalterable advantages belong to the industrialized nations, that is, they are in temperate zones and have the advantage of a healthy and invigorating climate as well as a food advantage. Two-thirds of the caloric values of the foods that the people of the earth consume are derived from cereal grains, the majority of which are produced in the temperate zones.

Years ago, the civilized world went through ages of reason, of faith, and of enlightenment. Currently, we are involved in an age of information. Billions of dollars are being invested worldwide in artificial intelligence, hardware, and software for corporations, schools, and the military. Hopefully, this will be translated into better transportation and communication. Energy

Plays a critical role in the development of an international market. Growing international economic interdependence is seen by many as the dominant beneficial development of the post-World War II period.

World energy demand grows spontaneously. The developing countries find their populations and incomes increasing as a result of manufacturing, mining, and agriculture being farmed out to labor-intensive societies. The developed economies provide such services as knowledge and its

application, finance, insurance, real estate, research, and development. Electrification, which is especially energy intensive, is receiving primary attention in the developing world, Nigeria inclusive. There are three trends that are currently discernible, with the prospect of becoming more apparent as time goes on: Many energy-intensive industries such as the process group (petrochemical manufacturing, etc.) will gravitate to countries where labor and natural resource costs are minimal; there will be a lessening of demand for energy-consuming goods in the more advanced countries; and because of the heightened efficiency in overall energy consumption, there will be a lowered demand per unit of economic activity (Ghosh, 2010).

Nuclear power is growing faster from the year 2000; acid deposition, the greenhouse effect, and ozone depletion are rapidly becoming of major concern, and, relatively speaking, nuclear power is the cleanest and safest of the currently available means for generating electricity. Hydropower and renewable energy sources is expected to make but a minor contribution to the marginal needs for the balanced of the century. Full use of hydropower was once predicted to come about in the developing world where untapped resources still remain, and also in such developed nations as Canada, whose hydropower power potential is enormous and whose political climate is most amenable to further development. Renewable such as biomass, solar power, and wind power have yet to affect the economies on the scale that is conducive to further development.

Many of the alternative technologies utilize a direct conversion from potential to electrical energy. Photovoltaic and fuel cells for example do not use a generator in electricity production and thus, have essentially no moving parts. The increased reliability should preclude the need for flexibility in generation capacity. Photovoltaic and wind power depend on many factors for the level of their output, most of which are outside the control of the operator. Although these facilities can be dispersed to reduce the variation in total output, only through the addition of electricity storage facilities will these technologies be useful for more than marginal production. Storage adds capital cost to technologies which are already expensive.

Alternative energy systems which are small, decentralized, and locally controlled fit with a demassification trend in technology and institution as we progress in the 21st Century. However, they must prove economic, reliable and efficient. This can only come about by their incremental inclusion into the conventional supply system. Fortunately, the electric supply industry might be receptive because it is at a point in history where it is afraid to move into major central station capital investments.

Solar energy is an important tool in eliminating pollution and creating a highly reliable electricity backup to electrical/electronic. Solar energy is an energy source that involves tapping the radiant

Light energy that is emitted by the sun and converting it into electricity. Homes that are powered by solar energy have been installed with batteries that have a capability of storing power that can operate electrical appliances such as computers, television, radio, laptops, i-pads, tablet, and refrigerators. Solar energy is the sun's rays (solar radiation) that reach the earth. This energy can

be converted into other forms of energy, such as heat and electricity. Solar energy, radiant light, and heat from the sun, has been harnessed by humans since ancient times using a range of eve revolving technologies. Solar energy technologies include solar heating, solar photovoltaic, solar thermal electricity, solar architecture and artificial photosynthesis, which can make considerable contributions to solving some of the most urgent energy problems the world now faces, Nigeria inclusive. Solar energy technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert, and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

During the past several years, in particular, since the now historic oil embargo of the 1973-74 heating season, solar energy has been recognized as an energy alternative which can be immediately implemented. Solar energy for space heating and cooling will probably continue to have broad acceptance when the application uses the energy during a large fraction of the year, the climate is sunny, conventional fuels are costly and the application requires moderate temperatures. Contrary to popular belief, solar heating is often more applicable in cold climates than in warm ones. The longer and colder the heating season, the greater the demand for the heat which is absorbed and stored by the solar system.

In many African countries' economic environment, one issue that has continued to stick out a sore thumb is the very epileptic power supply in those countries. Its debilitating impact on the economy is enormous. In the face of unreliable power supply, no sector of the economy can make meaningful progress. The challenge is to seek to ease the problem of electricity so that individuals and households including businesses can be better for it. The hope of constant power lies in seeking solutions of alternative electricity source by any other means, especially in the face of prolonged helplessness of power providing authorities in Nigeria. As incomes are dwindling, and cost of purchasing generators as alternative sources of power is escalating, it becomes necessary to create seamless power solutions especially for households and small businesses. This is why this study focuses on awareness and use of solar energy as alternative power source for ICT facilities in Kogi State. This is in order to create a niche solution to bridge the gap created by power providing agencies by deploying solar energy installation that may either stay as 'Stand Alone' or Backup system.

Statement of the Problem

One of the major hindrances to the penetration of information and communication technology (ICT) devices in under-served and un-served areas in the developing nations is the absence and inadequacy of electricity to power technological devices (Amaefule, 2012). Inadequate supply from the national grid, land and water pollution from oil spillage in the oil producing communities

among other factors have led Nigeria and indeed the world to look for alternative power supply such as solar energy. Unfortunately, utilization and development of solar energy is

Rising in other parts of the world but encountered with low pace of development and utilization in Nigeria. This low pace of development is due to the associated problems such as awareness, purchasing power, technology of installation and fabrications, governmental policy and politics, culture, Nigerian factor, among many other variables. It is in the light of this that this study intends to carry out a survey on the awareness and use of solar energy as alternative power source for ICT facilities in Kogi State and information centers.

Objectives of the Study

This study aims to achieve the following:

1. Find out the rate of knowledge of solar energy as alternative power source

2. Examine the level of awareness of solar energy as alternative power source

3. Find out the present major power sources for ICT facilities in Nigerian university libraries and information centers.

4. Investigate the rate of power supply for ICT facilities in Kogi State and information centers.

5. Investigate other available alternative power sources for ICT facilities in Kogi State and information centers.

6. Determine if the deployment of solar energy is cost effective in Kogi State and information centers

7. Find out the problems militating against abundant power supply for ICT facilities in Kogi State and information centers

Literature Review

In 2011, the International Energy Agency, said that the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change and keep fossil fuel prices lower than otherwise. These advantages are global (wikipeadia, 2011)

Solar energy is the radiant (light and heat) energy produced by the sun. The solar energy that reaches the earth can be used to produce electricity or heat through the use of solar collectors. Solar energy is a renewable resource whose use does not affect its future supply. Conventional power plants use fossil fuel or nuclear energy as heat source to boil water. The steam from the boiling water rotates a turbine, which activates a generator to produce electricity. Solar energy facilities use concentrating solar power (CSP) as the heat source to boil water, or they convert sunlight

directly into electricity using solar cells, also known as photovoltaic (PV). The CSP technologies are also referred to as solar thermal or thermo electric technologies, while PV Technologies are also referred to as solar electric or photoelectric technologies.

The main types of CSP systems are linear (that is parabolic trough and compact linear Fresnel reflector), power tower, and dish engine's plants consist of two parts: one that collects solar energy and converts it to heat and another converts the energy to electricity. The two types of PV technologies are flat plate and concentrating PV. Both PV technologies use solar cells that are

Made of semiconductor materials to absorb sunlight. The solar energy knocks electrons loose from their atomic, allowing electrons to flow through the material to produce electricity.

The average amount of solar energy reaching the ground has a maximum intensity of about 1.2kWm. (Duffie, 2008). Solar radiation received on earth has been increasing since the late 19th century according to Wilson (2003). Most developing countries occupy the areas that fall in the high radiation receiving zone of the globe (Mumah, Arinze and Adefila, 1991). This includes Nigeria. For instance, Umudike, a town in South-East Nigeria has an average daily insolation of about 7kWhm-2 (Asiegbu and Nduka, 2006). Solar insolation is the amount of solar energy that is incident on the earth's surface per unit area per day. It is a useful figure of merit for effective harnessing of solar energy.

In some developed countries, solar power generation has gone beyond the orthodox stand- alone or dedicated plants. Doors, windows and roofing materials now integrate solar cell elements as part of power generating devices in homes. For instance, it has been estimated that roofs could technically generate up to 40% of European Union electricity demand (CPR report, 2010).

Recently, efforts are being made in Nigeria to install solar- operated street and traffic light systems (Adewoye, 2008); and this has compliment towards decongesting the already congested tropical insolation figure of about 4.7kWm-2. This agrees with NASA's estimated value for the town (Dike et al, 2011)

Converting Solar Power into Energy Generation

According to Akinboro, Adejumobi and Makinde (2013), the following resources should be seriously considered when the issue of conversion of solar energy into power generation is on. Capacity of Battery Bank: In a given energy system, the group voltage of the battery bank according to Shimin (2008) should be same as the input voltage to the inverter. In a tropical location, it is not expected to have protracted number of days of cloud cover with sunlight. At most there may be one or two days of complete cloud cover at a stretch during the rainy season.

Charge/Discharge controller: Charge/Discharge controllers automatically regulate the amount of current going in or out of battery when charging or discharging gets to a set value. The discharging

controller switches off when the battery reaches over- discharge set point. The voltage set point depends on the battery used.

The Inverter: According to Asiegbu and Atuke (2005), an inverter converts dc power to ac power. The synchronous type is used for grid connected systems. Major consideration for applications include output wave form, power output, efficiency, output regulation and matching to applications. The use of energy has been a key to the supply of food, to physical comfort and to improving the quality of life beyond the rudimentary activities necessary for survival. The utilisation of energy depends on two factors: available resources and the technological skill to convert the resources to useful heat and work.

Utilization of Solar Electric Power

According to Norris (1988), solar electric power can be utilized in the following areas: Lighting: Incandescent lamps, discharge lamps, Photodiodes, lasers; heating: resistive, inductive, capacitive, radioactive, plasma; cooling: refrigeration and mechanical effort: motors, actuators,

Robots, electrophoresis, piezoelectricity. Other areas of solar electric power utilization are electrochemistry: catholic protection, batteries, preparation of chemicals; photo electricity: photovoltaic; communication: audio, video, data; control: automatic control; computers: calculators, information handling and storage and measurement: transducers, sensors display of information.

Man have only just begun to turn their scientific and technological ingenuity to the task of converting their most abundant and reliable energy source, sunlight, into electricity; the most convenient and adaptable form of energy. Before solar energy can provide electricity on a large scale, there are two technical problems to be solved. The first is the problems of converting the energy of the sun's radiation into electricity. The second has to do with the fact that the electricity must be available whenever and wherever it is needed, regardless of the weather, the season or the time of day. It must also be kept in mind that in the real world both objectives must be achieved at prices that are competitive with those of other sources of energy.

Methodology

Descriptive research design using survey method was adopted for this study. Questionnaire was designed and used as survey instrument. The population for this study includes the staff of Kogi State Polytechnic Lokoja, Kogi State (KSP), Federal Polytechnic Ida (FPI) and Nigeria Korea Freindship Institute Vocational and Advance Technology Lokoja, Kogi State (NKFI) ICT Solar in Polytechnics of Education. The population was made up of 100 staff selected from the sampled institutions for this study. They were randomly selected from Cataloguing and Classification, Automation, Acquisitions, Readers Services, Serials and Administrative departments. They were chosen based on their experience. They were chosen through purposive sampling technique. The

findings were presented in tabular form. In this investigation, simple percentage analysis was employed.

Data Analysis

A total number of 100 questionnaires were administered on 100 subjects. The 100 subjects that made up the sampled population were drawn from three universities in Ogun state. 87 questionnaires which represent 87% of the entire sample were returned, found appropriate, and fell into needed sample. Hence, 87 questionnaires were used for this analysis. The research questions were analyzed based on the institutions studied. Data analyses were presented in tabular form using simple percentage analysis.

Demographic Information

Table 1: Distribution by Institution

Institutions	KSP	FPI	NKFI	Total
Institutions	45(51.8%)	15(17.2%)	27(31%)	87(100%)

Table 1 shows the distribution of respondents by institutions. 45 respondents which represent 51.8% were from KSP, 15 respondents (17.2%) were from FPI while another 27 respondents (31%) were from NKFI.

Table 2: Respondents' Section

Cat and Class	Automation	Acquisition	Readers Svc	Serials	Admin	Total
27(31%)	8(9.2%)	10(11.5%)	27(31%)	10(11.5 %)	5(5.7%)	3(3.4%)

The table above shows that Cataloguing and Classification 27 (31%), Automation 8(9.2%), Acquisition section has 10 respondents (12.5%), Readers' Services 27(31%), Serials 10 (11.5%) and Administrative section 5 (5.7%).

Table 3: Respondents' Age

>60	50-59	40-49	30-39	20-29	No Response
-	12(13.8%)	36(41.4%)	20(23%)	16(18.4%)	3(3.4%)

This table reveals that respondents between age 50-59 were 12 (13.8%), age 40-49 were 36 (41.4%), age 30-39 were 20 (23%) and age 20-29 were 16 (18.4%).

Table 4: Respondents' Sex

Male	Female	No Response
40(46%)	26(29.9%)	21(24.1%)

This table also shows that only 66 out of 87 respondents indicated their sex. Male 40 (46%) and female 26 (29.9%).

Table 5: Respondents' Status

ICT	ICT OFFICER	ICT ASSIST	ICT PORTERS	Administrative	Others
28(32.2%)	20(23%)	24(27.6%)	9(10.3%)	5(5.7%)	1(1.1%)

The respondents' status are shown in this table. Librarian 28 (32.2%), Library Officer 20 (23%), Library Assistants 24 (27.6%), Library Porters 9 (10.3%), Administrative staff 5 (5.7%), others 1 (1.1%)

Table 6: Awareness on Solar Energy as Alternative Power Source

	QUESTIONS	YES	%	NO	%
1	Do you know what solar energy is?	87	100	-	-
2	Have you experienced solar energy as alternative power source before?	48	55.2	39	44.8
3	Do you hear/read about solar energy as alternative power source?	84	96.6	4	3.4
4	Do you know anything about solar energy equipment?	66	75.9	21	24.1
5	Do you have alternative power source in your library?	63	72.4	24	27.6
6	Are you aware that solar energy can power your ICT equipment?	81	93.1	6	6.9
7	Do you believe that erratic power supply can be mitigated to a large extent?	87	100	-	-

Table 6 on awareness on solar energy as alternative power source depicts that all the respondents have good knowledge of what solar energy is as they all responded in affirmative. 48 (55.2%) have experienced solar energy as alternative power source before while 39 (44.8%) have not. 84 (96.6%) have read and heard about solar energy as alternative power source. 66 (75.9%) are well informed about solar energy equipment while 63 (72.4%) indicated that they have alternative power source in their libraries. 81 (93.1%) respondents were aware that solar energy can power their ICT equipment while all the respondents, 87 (100%) believe that erratic power supply can be mitigated to a large extent.

Table 7: Use of Solar Energy as Alternative Power Source

	Items	SA	A	D	SD
1	Solar energy is an alternative power source from sunlight.	87(100%)	-	-	-
2	Many people are not aware of the solar energy as alternative power source.	30(34.5%)	30(34.5%)	12(13.6%	15(17.2%)

3	Solar energy equipment are not easily acquired	24(27.6%)	39(44.8%)	12(13.6%)	12(13.6%)
4	Solar energy equipment are not easily deployed	30(34.5%)	30(34.5%)	15(17.2%)	12(13.6%)
5	Electrical/electronic equipment should come with alternative power source.	45(51.7%)	39(44.8%)	3(3.4%)	-
6	Organizations should include alternative power source in their maintenance policy.	30(34.5%)	51(58.6%)	3(3.4%)	3(3.4%)
7	ICT management should prepare against	45(51.7%)	42(48.3%)	-	-
8	ICT management should evolve maintenance policy that includes alternative power source.	36(41.4%)	51(58.6%)	-	-
9	Human resources in the libraries require alternative power source to function effectively.	30(34.5%)	57(65.5%)	-	-
10	Increase in ICT facilities in libraries necessitates deployment of alternative power source.	33(37.9%)	54(62.1%)	-	-
11	The economic advantage of solar energy deployment as alternative power source is greater than installation cost.	45(51.7%)	30(34.5%)	6(6.8%)	6(6.8%
12	The deployment of solar energy equipment is cost effective to the libraries.	36(41.4%)	30(34.5%)	15(17.2%)	6(6.8%)

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Key: SA-Strongly Agree, A-Agree, SD-Strongly Disagree, D-Disagree

This table on the use of solar energy as alternative power source shows that all the respondents for the study 87(100%) agreed that solar energy is an alternative power source from sunlight. 60 (69%) also agreed that many people are not aware of the solar energy as alternative power source while 37 (30%) disagreed. 63 (72.4) respondents agreed that solar energy equipment are not easily acquired while 25 (27.6%) disagreed. 60 (69%) respondents also agreed that solar energy equipment are not easily deployed while 27 (31%) disagreed. 84 (96.5%) respondents agreed that electrical/electronic equipment should come with alternative power source. It was also agreed by 81 (95.1%) respondents that organizations should include alternative power source in their maintenance policy. All the respondents 87 (100%) agreed that library management should prepare against incessant power outage. They also agreed that human resources in the libraries require alternative power source to function effectively. They equally agreed that increase in ICT facilities in libraries necessitates deployment of alternative power source. 75 (86.2%) respondents agreed that the economic advantage of solar energy deployment as alternative power source is greater than installation cost while 12 (13.6%) disagreed. 66 (75.9%) agreed that the deployment of solar energy equipment is cost effective to the libraries while 21 (24%) respondents disagreed,

Table 8: Problems Militating Against Abundant Power Supply for ICT Facilities in Kogi State and Information Centers.

	Problems	Response	%
1	Inadequate funding	24	27.6
2	Government policy	15	17.2
3	Corruption	45	51.7
4	Inadequate knowledge of alternative power sources	3	3.4
	Total	**87**	**100**

This table on problems militating against the abundant power supply in Kogi State ICT and information centers shows that corruption has the highest response rate of 45 (51.7%) among the problems that militate against abundant power supply in Kogi State and information centers. This was followed by inadequate funding 24 (27.6%) and government policy 15 (17.2%). Inadequate knowledge of alternative power sources has the lowest number of 3 (3.4%) respondents.

Results and Discussion of Findings

Awareness on Solar Energy as Alternative Power Source

The result of findings of this study on awareness on solar energy as alternative power source reveals that all the respondents have good knowledge of what solar energy is as they all responded in affirmative. 48 (55.2%) have experienced solar energy as alternative power source before while 39 (44.8%) have not. 84 (96.6%) have read and heard about solar energy as alternative power source. 66 (75.9%) are well informed about solar energy equipment while 63 (72.4%) indicated that they have alternative power source in their libraries. 81 (93.1%) respondents were aware that solar energy can power their ICT equipment while all the respondents, 87 (100%) believe that using solar energy, erratic power supply can be mitigated to a large extent. These findings are not in tandem with Akinboro, Adejumobi and Makinde (2013) study that discovered that the awareness on solar energy as alternative power source was low among the people. The case of awareness on topical issues such as solar energy as alternative power source in the ICT and among the ICT operators and information specialists in particular touches on the professional obligations of the ICT operators as custodians of knowledge. This could justify the reason for high level of awareness among the respondents for this study. Amaefule (2012) noted that one of the major hindrances to the penetration of information technology and telecommunication devices in under-served and un-served areas is the absence and inadequacy of electricity to power technological devices. Even for big operators in ICT sector, inadequacy of electricity has constituted a major obstacle. This undoubtedly has increased the quest for alternative power sources among the teeming populace.

The Use of Solar Energy as Alternative Power Source for ICT

Findings from this study on the use of solar energy as alternative power source show that all the respondents for the study 87(100%) agreed that solar energy is an alternative power source from sunlight. 60 (69%) also agreed that many people are not aware of the solar energy as alternative

power source while 37 (30%) disagreed. 63 (72.4) respondents agreed that solar energy equipment are not easily acquired while 25 (27.6%) disagreed. 60 (69%) respondents also agreed that solar energy equipment are not easily deployed while 27 (31%) disagreed. On acquisition and deployment of solar energy as alternative power source, Akinboro, Adejumobi and Makinde (2013) found that when equipment and installation cost of solar energy were compared with other energy supply sources, solar energy was higher on the short run but, it was however cheaper on the long run. According to them, PV source is more expensive up to 4 years of installation. This is because solar energy components are very expensive and they are mostly imported except the cables and few accessories but beyond 5 years, PV power devices become more attractive because of low running cost. 84 (96.5%) respondents agreed that electrical/electronic equipment should come with alternative power source. It was also agreed by 81 (95.1%) respondents that organizations should include alternative power source in their maintenance policy. All the respondents 87 (100%) agreed that library management should prepare against incessant power outage. They also agreed that human resources in the libraries require alternative power source to function effectively. They equally agreed that increase in ICT facilities. Deployment of alternative power source. 75 (86.2%) respondents agreed that the economic advantage of solar energy deployment as alternative power source is greater than installation cost. 66 (75.9%) agreed that the deployment of solar energy equipment is cost effective to the ICT. Despite the potential of producing solar panels and possibly cells in Nigeria to make up for shortage of energy required in the ICT sector, Amaefule (2012) observed that there is a limit to what this source of energy can do for the country. He asserted that one of the major limitations is in the quantity of the sunlight that can be converted to electricity using the photovoltaic effect as well as the initial investment required to acquire solar panels for meaningful production in the ICTs. According to Callfinder.com, the best solar panels at the moment can convert only about 20 per cent of the solar energy they receive into usable electricity. Implying that a high number of panels are needed to satisfy even a single home's energy needs. For that reason, solar power systems are still prohibitively expensive and require large amounts of surface area to create a relatively small amount of energy. Another limitation for solar power is intermittency. Solar power is extremely predictable, making it an easy resource to work with, but it is available only during the day under sunny skies. Although a definite limitation, this problem too is solvable with technology. The key is energy storage.

Adewoye (2013) submitted that solar energy also known as photovoltaic (PV) technology has virtually unlimited potential to provide a safe energy supply that is clean and environmentally friendly in contrast to most conventional energy production technologies. He said, PV technology is particularly well suited for use in Nigeria since most parts of the country lie within the tropical

region blessed with abundant sunshine all year round and also because of the isolated pattern of human settlement. He noted that the establishment of a PV plant in Nigeria is envisaged to accelerate the development, application, adaptation and diffusion of PV technology in the country. In addition to Karshi plant, there is need for setting up similar plants in the six geo-political zones of the country to bring off-grid electricity to the rural communities.

Problems Militating Against the Abundant Power Supply for ICT Facilities in Kogi State Polytechnics ICT and Information Centers

On the problems militating against abundant power supply in Kogi State Polytechnics ICT and information centers, the results of findings from this study show that corruption has the highest response rate of 45 (51.7%) among the problems that militate against abundant power supply in Kogi State Polytechnics ICT and information centers and information centers. The issue of corruption in Kogi State is worrisome. Corruption is endemic and has permeated virtually every sector of the economy, power inclusive. In spite of all efforts to curb the menace of corruption through the establishments of various anti-graft bodies, the hydra headed nature of corruption in Nigeria makes it a herculean task. The involvement of government officials and several ministries and parastatals has helped to entrench corruption in the power sector. The huge amount of resources usually voted for this sector especially since the return of democracy in Nigeria has gone in the drain. The present government has however doubled its efforts through the introduction of Bureau of Public Enterprises (BPE) which led to the sack of Power Holding Company of Nigeria (PHCN) and its perceived corrupt officers. National Electricity Company (NEC) has since been established and the private investors under National Electricity Company have taken over the operations throughout the nation. Paucity of fund has been identified among the private investors whose levels of operations have also been found unsatisfactory among their customers. There is however high optimism that power generation, transmission and distribution would be better soonest. Corruption was followed by inadequate funding 24 (27.6%) and government policy 15 (17.2%). Akinboro, Adejumobi and Makinde (2013) posited that, in Nigeria, there is no clear government policy in the areas of renewable energy like in the case of other energy generating sources like hydro, thermal, and nuclear and others. In their opinion, the people in government who are to make policy and the common man on the street are very much unaware of the existing capacity of solar energy. The print media also has not produced enough publicity on the subject matter. Inadequate knowledge of alternative power sources 3 (3.4%) was however the least problem among the respondents for this study.

Other Findings

Questions were also raised to know other power sources for ICT facilities in the respective Polytechnics investigated. The results show that National Electricity Companies and power generators were mostly used interchangeably by the respondents' ICTs. None of the libraries sampled were using either wind, thermal, solar or hydro. The respondents were also asked to

indicate the rate of power supply for ICT facilities. Respondents from KSP had the highest rate of power supply for ICT facilities (21-24 hours). Respondents from FPI indicated that they have power supply for ICT for only 5-8 hours per day while NKFI has the least power supply for ICT (1-4 hours). When asked how often the respondents hear/read about alternative power source, 60 (69%) indicated that they hear/read about alternative power source regularly while 27 (31%) respondents indicated that they seldom hear/read about alternative power source.

Conclusion

Based on the result of findings, this study concludes that all the respondents have good knowledge of what solar energy is as they all responded in affirmative. Majority of the respondents, 48 (55.2%) have experienced solar energy as alternative power source for ICT before. 84 (96.6%) have read and heard about solar energy as alternative power source. 66 (75.9%) are well informed about solar energy equipment while 63 (72.4%) have alternative power source in their libraries. 81 (93.1%) respondents were also aware that solar energy can power their ICT equipment while all the respondents believe that using solar energy, erratic power supply can be mitigated to a large extent. In addition, this study concludes that many people are not aware of the solar energy as alternative power source; solar energy equipment are not easily acquired and deployed; electrical/electronic equipment should come with alternative power source and organizations should include alternative power source in their maintenance policy. The respondents agreed that library management should prepare against incessant power outage. They also agreed that human resources in the libraries require alternative power source to function effectively. Increase in ICT facilities necessitates deployment of alternative power source. The economic advantage of solar energy deployment as alternative power source is greater than installation cost hence, the deployment of solar energy equipment is cost effective to the ICTs.

Corruption was identified as the major problem militating against abundant power supply in Nigeria as a nation. National Electricity Companies and power generators were mostly used interchangeably by the respondents' ICTs. KSP had the highest rate of power supply for ICT facilities. The respondents hear/read about alternative power source regularly.

Solar technology is an aspect of power production that many governments have found useful to mitigate the power problems of their countries. The Karshi panel plant in Nigeria has shown its capacity and ability to provide solar panels that should be able to drive technology in Nigeria. Plenty of sunlight strikes the earth's surface on any given day, enough to power the entire world for years. Solar power's limitations lie in our ability to capture, convert and store solar energy. It is therefore certain that solar energy can be useful in ICT operations even where power requirement is enormous. All that is required is ability to capture, convert and store solar energy.

Recommendations

1. There should be more awareness programs on solar energy as alternative power source.

2. Electrical/electronic equipment should be supplied with alternative power source to the ICT.

3. Organizations should include alternative power source in their electronic equipment maintenance policy.

4. ICT management should prepare against incessant power outage by providing alternative sources.

5. Increase in ICT facilities in Polytechnics necessitates deployment of alternative power source, it then implies that human resources in the ICT require alternative power source to function effectively.

6. The economic advantage of solar energy deployment as alternative power source is greater than installation cost hence, the deployment of solar energy equipment is cost effective to the libraries.

7. Corruption should be fought against in order to enjoy the commonwealth.

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