UTILIZING SOLAR ENERGY AS SOLUTION TO ACHIEVE SUSTAINABLE POWER IN NIGERIA

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Abstract

Energy is an important factor in all the sectors of any country's economy. Nigeria suffers from an inadequate supply of usable energy due to the rapidly increasing demand, which is typical of a developing economy Research indicate that, Nigeria lying in the tropics, receives abundant sunshine which can be converted to other forms of energy to achieve sustainable power in Nigeria .this paper discusses the utilization of solar energy to achieve sustainable power in Nigeria, the distribution of solar energy its conversion, its status and developmental projects in Nigeria as well as factors affecting its utilization.

Keywords: Energy, solar energy, sustainable power, Nigeria.

Introduction

Energy plays the most vital role in the economic growth, progress, and development, as well as poverty eradication and security of any nation. Uninterrupted energy supply is a vital issue for all countries today. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly (Ramchandra and Boucar, 2011). Energy is an important factor in all the sectors of any country's economy. The standard of living of a given country can be directly related to the per capita energy consumption of the country. Energy supports the provision of basic needs such as cooked food, a comfortable living temperature, lighting, the use of appliances, piped water or sewerage, essential health care (refrigerated vaccines, emergency, and intensive care), educational aids, communication (radio, television, electronic mail, the Worldwide Web), and transport. Energy also fuels productive activities including agriculture, commerce, manufacturing, industry, and mining. Conversely, a lack of access to energy contributes to poverty and deprivation and can contribute to the economic decline.

Sustainable energy can be defined as energy which provides affordable, accessible and reliable energy services that meet economic, social and environmental needs within the overall developmental context of society, while recognising equitable distribution in meeting those needs (Davidson, 2006). Sustainable energy will, however, require new approaches in the mobilisation of energy resources for development. This would involve: shifts to renewable energy sources; development and wide dissemination of sustainable and renewable energy technologies; energy efficiency and conservation; and technological developments that allow the use of fossil fuels in a cleaner way (Tsighe, 2001).

Nigeria suffers from an inadequate supply of usable energy due to the rapidly increasing demand, which is typical of a developing economy. Paradoxically, the country is potentially endowed with sustainable energy resources. Nigeria is rich in conventional energy resources, which include oil, national gas, lignite, and coal. It is also well endowed with renewable energy sources such as wood, solar, hydropower, and wind (Okafor and Uzuegbu, 2010).

Concept of renewable energy

The term “renewable energy” covers all forms of energy generated from natural resources such as sunlight, wind, water (or hydro power), tide, geothermal heat, biomass and bio fuels. They are derived from natural processes that are constantly replenished and each of them has characteristics that determine where and how they are used. Several renewable energy projects in many countries have shown clearly that renewable energy can directly contribute to poverty alleviation by providing a substantial amount of energy needed for creating businesses and employment especially in rural communities that have not yet been connected to the National grid (Federal Ministry of Environment, 2013).

Renewable energy is becoming more and more prevalent around the world, but it is still not the dominant energy resource. The primary 6 types of renewable energy are solar, wind, biomass, hydro power, geothermal and bio fuels. Each of these renewable energy sources

provides an alternative to traditional energy generation and can be reproduced, reducing our footprint on the environment.

Solar energy and Nigeria

In one form or another, solar power has been around for thousands of years. As a renewable source of free, green energy, technology has found a way of harnessing the sun's energy via solar panels which are used either to generate electricity (solar photo voltaic) or to produce heat to warm water (solar thermal). A popular choice in a growing renewable energy market, solar technology doesn't generate greenhouse cases and is environmentally friendly.

Solar energy can be seen as the anchor behind various forms of renewable energy. It anchors hydro power where the hydrological cycle is being controlled by the sun as well as Wind Power where the movement of air is due to the heating effect of the sun on the atmosphere. In general, heat, kinetic energy, electrical energy and chemical energy can be provided via solar energy conversion (Tyagi et al., 2013). In theory, solar energy can be perceived as an ideal energy source, because it is free and virtually limitless. However the technological barriers with regards to its collection, distribution and storage are great. Solar energy forms the basis or acts as the source of all other forms of energy on earth. Hence with the increase in intensity of solar radiation reaching the earth, it is paramount that this invaluable resource be put into adequate and efficient use in various areas of life. Solar energy utilization takes its root in the early ages when solar energy (sun) was used as a clock, as a compass, for preservation of food etc. In this modern age we have simply improved upon the findings of the old to get greater value, efficiency and time saving. To this end solar energy is ever growing and ever expanding in its utilization.

Nigeria, having a land mass of 923,768sq.km, is situated in the West African region and lies between longitudes 3 degrees and 14 degrees and latitudes 4 degrees and 140 degrees (Nigeria Embassy, 2013). Nigeria receives abundant sunshine all the year round being just above the equator. The sunshine duration averages 6.5 hours daily with an average flux of 5.55 kWh per square meter per day. This implies that Nigeria receives 4.851x 1012 kWh of energy per day from the sun. The solar radiation intensities range from 3.5-7.0 kWh per square meter per day increasing from the South to the North (Oseni, 2012). This energy source could be available for 26% of the day (9.00am-4.00pm). These facts and figures regarding Nigeria's geographical location clearly indicate that the potential to generate significant amount of electrical energy from solar energy is very high for Nigeria. However, very little has been done in this direction as the government is yet to take pragmatic steps towards developing and implementing policies and plans that will serve as a base line on which solar energy utilization in Nigeria can thrive. (Ohunakin et al 2014).

Three different solar radiation zones can be defined in Nigeria: zones I, II and III with each zone having different radiation levels that may be needed for a particular project selection and sizing (Ohunakin et al 2014).

Zone I comprises of all the states in the North-East geo-political zones (Borno, Yobe, Jigawa, Kano, Kaduna, Bauchi, Gombe, Adamawa, Plateau and Katsina) With the high solar

radiation incident on the horizontal surface, the country has excellent and viable potential for large scale solar photovoltaic (PV) especially in the semi-arid region.

Zone II consisting of the North-West and North-central belt of the country (Sokoto, Zamfara, Kebbi, Niger, Abuja, Nassarawa, Taraba, Kwara, some section of Plateau and Katsina); also have viable solar radiation that may be required for most solar projects.

Low potential of annual global solar radiation exist in zone III (comprising all locations in the South region of the country including the coastal region) Oyo, Osun, Ekiti, Kogi, Benue; zone III can be suitable for stand- alone PV systems. Furthermore, some states/locations in the South-West and South-East regions can readily support decentralized solar energy projects (Ohunakin et al 2014).

Converting solar energy to power

Solar energy works by capturing the sun's energy and turning it into electricity .Our sun is a natural nuclear reactor. It releases tiny packets of energy called photons, which travel the 93 million miles from the sun to Earth in about 8.5 minutes. Every hour, enough photons impact our planet to generate enough solar energy to theoretically satisfy global energy needs for an entire year.

When photons hit a solar cell, they knock electrons loose from their atoms. If conductors are attached to the positive and negative sides of a cell, it forms an electrical circuit. When electrons flow through such a circuit, they generate electricity. Multiple cells make up a solar panel, and multiple panels (modules) can be wired together to form a solar array. The more panels you can deploy, the more energy you can expect to generate.

Photovoltaic (PV) solar panels are made up of many solar cells. Solar cells are made of silicon, like semiconductors. They are constructed with a positive layer and a negative layer, which together create an electric field, just like in a battery.

PV solar panels generate direct current (DC) electricity. With DC electricity, electrons flow in one direction around a circuit. This example shows a battery powering a light bulb. The electrons move from the negative side of the battery, through the lamp, and return to the positive side of the battery.

With AC (alternating current) electricity, electrons are pushed and pulled, periodically reversing direction, much like the cylinder of a car's engine. Generators create AC electricity when a coil of wire is spun next to a magnet. Many different energy sources can "turn the handle" of this generator, such as gas or diesel fuel, hydroelectricity, nuclear, coal, wind, or solar.

AC electricity was chosen for the U.S. electrical power grid, primarily because it is less expensive to transmit over long distances. However, solar panels create DC electricity. DC electricity gets into the AC grid via an inverter.

A solar inverter takes the DC electricity from the solar array and uses that to create AC electricity. Inverters are like the brains of the system. Along with inverting DC to AC power, they also provide ground fault protection and system stats, including voltage and current on AC and DC circuits, energy production and maximum power point tracking.

Central inverters have dominated the solar industry since the beginning. The introduction of micro-inverters is one of the biggest technology shifts in the PV industry. Micro-inverters optimize for each individual solar panel, not for an entire solar system, as central inverters do. This enables every solar panel to perform at maximum potential. When a central inverter is used, having a problem on one solar panel (maybe it's in the shade or has gotten dirty) can drag down the performance of the entire solar array. Micro-inverters, such as the ones in SunPower's Equinox home solar system, make this a non-issue. If one solar panel has an issue, the rest of the solar array still performs efficiently.

Solar energy development in Nigeria

For decades, solar thermal has been constantly enjoying very high level utilization by rural dwellers for agricultural processing in purposes including drying of agricultural products such as grains, cassava (tubers or marsh), yam flakes, meat, fish, fruits, kernels, drying of manure, hides and skins, cooking and frying of agricultural products which are not preserved or sold raw. Other areas of solar energy utilizations include heating and lighting of animal pens, pumping of water and irrigation, food and vaccine storage (Yohanna and Umogbai 2010). In addition to these, solar energy has also found wide usage in Nigeria viz: solar street lightings, solar refrigerators, solar cookers, solar-powered water pumps, etc; different applications exist in the form of solar thermal and solar PV. Solar energy devices (mainly solar thermal) have been designed, built or adapted by research institutes and tertiary institutions across the country. Notable among the products in existence locally is the built 1000-litre capacity solar water heating system at the Usman Danfodiyo University Teaching Hospital, Sokoto in 1998 by the Sokoto Energy Research Centre (SERC), solar driers, solar chick brooders and solar absorption refrigerators developed at the National Centre for Energy Research and Development (NCERD). Solar PV found widespread usage in street lighting, but other pilot projects including water pumping, vaccine refrigerators, community lighting and few stand-alone mini grids installed and scattered across the country by the government or any of its agency like the Energy Commission of Nigeria (ECN), Federal Ministry of Power (FMoP) and the Federal Ministry of Science and Technology (FMoST) also exist

However, synergy does not exist among all the major energy players (ECN, FMoP, FMoST, other private donors and state parastatals that are involved in energy projects), hence, no comprehensive project database exist for renewable projects in the country. Furthermore, all existing projects are either off-grid light applications of few kWp or stand-alone mini-grid at the moment; off-grid hybrid or grid connected solar projects do not exist across the country.

According to Sambo 2010, solar PV installations are growing in Nigeria. A survey in Bala et al. 2000 on PV installations in over ten Northern states of Nigeria, showed that the distribution in application by type includes: water pumping (57%), rural-clinic (for

refrigeration and lighting (24%)), communications (television and radio (10%)), village and domestic lighting/TV viewing (8%) and experimental room air conditioning occupying 1%. All these have increased in recent years due to the appalling power situation in the country. In addition, low-powered solar appliances in kWp (solar lanterns, solar battery chargers and other solar-powered home appliances) can be seen on retails across the country.

Solar energy projects in Nigeria

Based on the 1999 national survey by the Nigeria Energy Commission, there are a total of 33 companies that were active in Solar PV by then, with over 200 solar PV installations, in the country as at 1998, with capacities ranging from 3.5 to 7.2 kWp (Energy Commission of Nigeria). The Solar Electric Light Fund (SELF), an NGO based in USA. Jigawa State Government initiated a proposal to bring solar-generated electricity (PV) to power essential services in 3 villages of Jigawa State in 2001 (Chendo, 2002). Research done by Awogbolomi and Komolafe (2011) indicated notable solar energy projects in Nigeria to include:

1. Street lighting in Ado Ekiti, Ekiti State,
2. 7.2kWp Kwalkwalawa Village Electrification, Sokoto State
3. 1.87kWp Iheakpu-Awka Village Electrification/TV Viewing, Enugu State
4. 1.5kWp Nangere Water Pumping Scheme , Sokoto State
5. 2-tonne Solar Rice Dryer, Adani, Enugu State, and
6. 1.5-tonne Solar Forage Dryer, Yauri, Kebbi State.

Other new investments in the solar energy sector in Nigeria include;

1. 50 MW solar farms in Kaduna State by the Synergent Group
2. 100MW solar farm in Bauchi State by the Nigeria Solar Capital Project and Gigawatt Solar, 60MW in Katsina State by the Nigeria-German Energy Partnership
3. 20MW solar energy plant owned by Katsina State.

These projects are aimed at reducing the acute energy poverty in Nigeria, reduce green house gas emission from use of diesel generators, and enhance sustainable energy use in Nigeria. In 2013, President Goodluck Jonathan inaugurated the "Light-Up Rural Nigeria" in Durumi Community, Bwari Area Council, Abuja with the intent that renewable energy will be used to generate electricity for rural communities, especially areas not connected to the national grid in all the 36 states of the federation (Premium Times, 2013). It was reported recently that SkyPower FAS Energy has entered into agreements with both the Federal Republic of Nigeria Government and the Delta State Government for the setting up of utility-scale solar photovoltaic (PV) projects totalling 3,000MW within Nigeria and Delta State (www.powertechnology.com). The project is set to be developed within five years and will lead to the production of clean, sustainable and cheap electricity that will meet the growing energy needs of Nigerians.

Advantages of solar energy utilization

1. Renewable source of electricity

2. The conversion of electricity is fast and immediate – very direct this means you do not need a generator if you have a solar panel
3. No moving parts and need minimal maintenance with no supervision
4. Can operate for between 20 and 30 years life-line
5. There is minimal or no environmental impact, as they do not give out any wastes.

Factors affecting solar energy utilisation

Factors affecting solar energy utilisation in Nigeria are many and varied:

1. The high initial cost of investment of solar photovoltaic (PV) devices.
2. Lack of manpower and the desired technological skills.
3. Low- level of awareness also contributes a significant quota.
4. Lack of effective National Energy Policy.
5. Absence of establishment such as renewable energy data recording stations amongst others imposes serious setbacks on the research and applications of renewable energy related products.

Conclusion

Energy is an important factor in all the sectors of any country's economy. The standard of living of a given country can be directly related to the per capita energy consumption of the country fuels productive activities including agriculture, commerce, manufacturing, industry, and mining. Sustainable energy will, however, require new approaches in the mobilisation of energy resources for development. This would involve: shifts to renewable energy sources. Nigeria suffers from an inadequate supply of usable energy due to the rapidly increasing demand, which is typical of a developing economy. Research indicates that, Nigeria lying in the tropics, receives abundant sunshine which can be converted to power. Proper utilization of this abundant solar energy is the solution to achieve sustainable power in Nigeria.

Recommendation

1. Government should subsidise the cost of importation of solar PV devices.
2. Government should step up her campaign on reduction of illiteracy in Nigeria.
3. Extensive research in solar energy utilization should be given special attention.
4. Introduction of renewable energy incentives similar to the "feed-in-tariffs" by government will enhance increased consumption of renewable energy related products.
5. Increase in the level of awareness on the merit of investment of/consumption of renewable energy products, and
6. More research centres on renewable energy technology should be established and existing ones to be equipped properly.

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