

SOLAR ENERGY AS A MEANS OF IMPROVING ELECTRICITY IN NIGERIA

Author: Adedeji Aduragbemi Joseph

1.0 ABSTRACT

The rapid changing of technology and related human activities leads to tremendous increase of energy used. There have been a lot of efforts to meet the global demand of this energy used, 90% of global energy supply in Nigeria totally depends on fossil fuel, hydropower and other conventional energy resources. Despite all these, energy is not stable. The power sector is essential in a developed economy, and to develop Nigeria's economy there must be increase in the power generation. The effect of excessive combustion of fossil fuel to generate energy has contributed to negative environmental consequences such as global warming and environmental pollution. Energy from the Sun is on the promising alternative energy resources because of its availability in almost every part of the world. Nigeria receives lots of sunshine all year round due to the geographical location. Research has it that on the average, each square meters receives about 2000 KWH annually, it is practically limitless, will not be exhausted in lifetime with low cost of production. Technology has been able to convert the sunlight to electricity with the help of solar panels and some accessories with no environmental hazards. It is anticipated that the reform method theorize in this paper will bring economic growth and transformation to the nation's energy supply.

KEYWORDS: Alternative energy resources, Economic growth, Lifetime, Solar energy, Solar panels.

2.0 INTRODUCTION

Energy is an important and crucial ingredient in the development and progress of a country both economically and socially (Samson, A.A. 2014). A country's economic totally depends on Energy resources and it's also essential to life and living organism. Lack of the energy leads to poverty and deprivation, even economics recession. Nigeria has being struggling with energy crisis for about 20 years now, which has largely contributed to poverty by paralyzing industries and even commercial activities. Nigeria has being generated power majorly from fossil fuel and hydropower; generating about 4000MW- 5000MW, the power generated, transmitted and distributed is not enough for the basic household and even industries demands. According to CREN (2009), the power outages brought about a loss of 126 billion Naira annually, apart from this great loss to the country's economy, it has also improved environmental hazard and air pollution due to constant usage of petrol and diesel generators in different homes and industries. Today 60%-70% of Nigerians does not have access to Electricity leading to low in productivity, unemployment, high cost of living, etc. To meet the demand many household and industries needs there must be an alternative way of generating energy through renewable sources.

The main goal of this paper is to consider solar energy as an alternative energy source. The 86% of electrical generation come from fossil fuel; which is vulnerable to a great risk and negative environmental issues such as global warming which is a serious environmental hazard and environmental pollution i.e. carbon dioxide from exhaust engines. The remaining 14% of power generation comes from hydropower, which is known as the best, but having another source of generation will improve energy efficiency of Nigeria (Sunday olayinka, 2012). Over million years, the sun has been given natural light to the world and will continue to brighten our lives. Sun is one among renewable sources of energy that continually replenished.

Technology has been ready to use the energy generated from the sun to supply electricity. The energy from the sun is named **Solar Power** and it is referred to as the radiation from the sun to the earth. Solar energy is practically limitless, can't be exhausted in a lifetime without environmental emissions and it's much available in every part of the world. The quantity of solar energy emitting from the sun to the earth daily is equals many millions of burnt coal to supply energy. Africa is thought-through as the sun continent or part of the earth that the sun's influence is unequalled. According to the world sunshine map, Africa receives a lot of sunlight all round the year. Africa is one of the continent in the world full of renewable energy resources most especially Solar energy (*solar energy in Africa, Wikipedia, 2020*). Nigeria is one of the countries in Africa that is opportune to benefit from available renewable energy resources. Nigeria has a good climate conditions and there's sunlight all round in a year due to its geographical location i.e. close to the equator (Sunday olayinka, 2012). According to the USAID, on average, each square meters receive about 2000 kilowatts per hour (2000 kWh) yearly that is, irradiation = 2000 kWh/m²/year which equals to 5.5 Kilowatts per hour daily; these can produce enough electricity for the country. Also, the "peak sun hour" is described the amount of solar energy daily.

Below are the climate zones in Nigeria with their Peak sun hour values.

Climate zones	Peak Sun Hour	Example location
Mangrove swamp	4	Yenegoa, Calabar, Warri
High rain forest	4.5	Lagos, Ibadan, Abeokuta
Guinea savannah	5	Makurdi, Gboko
Sudan savannah	5.5	Kano, Kastina, Sokoto
Sahel savannah	6	Maiduguri, Jos, Bauchi

Information by USAID

Table 1



Figure 1

Average sunlight in a day is about 3 hours to 7 hours. The northern part of Nigeria has the highest sunlight hours of about 8 hours while the mangrove swamp has about 3-4hours sunlight. Countries in Africa like Republic of South Africa, Ghana, Algeria, Morocco and Egypt are increasing solar energy system on a oversized scale to boost stability of electricity. South Africa has the top solar energy resources of about 1,329 MW installed in 2016 and reaching to increase the energy generation to realize 8,400 MW by 2030. Morocco has about 3000 hours annually sunshine having about 160 MW capacity which is in a position to supply electricity for 650,000 people within country and also going to increase the the solar energy generation by 2020 to 2000 MW. Ghana also has about 20 MW solar energy plant (The five biggest solar markets in Africa, **LSE 2017**).

Some developed countries like China, Canada, USA and many more has adopted this solar energy system to produce electricity and heat. In the United States of America, about 7.7 Giga watts of solar energy installed in the country, this power generated is more than enough to provide electricity for 14.5 million household including industries. There are enough individual solar installations of about 2.3 million installations, ranging small households to large utility-scale systems that add hundreds of megawatts of clean electricity to the power grid and also in Europe, about 500Megawatt per hour are generated from solar energy system [Wikipedia 2020]. Energy supports the basic needs of life such as cooking, suitable living temperature, lighting, communication, essential health care, the use of appliances and even transportation.

Most projects in higher institutions today are based on renewable energy resources most especially Solar energy. Recently Yaba College of Technology finial year students design and construct an electric car using solar panels and batteries, instead of fossil fuel (Gas). To enhance the developmental trends in Nigeria, the unreliable energy sector must be supported with a sustainable source of power supply through solar power supply.

3.0 BODY

Solar energy was discovered in 1839, French Physicist Alexandre Edmond by developing a photovoltaic effect. The PV effect create an electric charge when expose to light using selenium and platinum as conductor. Aleksandr Stoletov invented the first solar cell based on the photovoltaic effect in the late 19th century. In 1950s Bell Labs develop silicon based solar cell which led to the manufacturing of solar panels. Throughout 1950, the potency of the cell kept on rising, from 8% to 14% in 1960, but not affordable for commercial use. Dr Elliott and Exxon designed less expensive solar cell. Since 2008, solar efficiency has been increasing and the price is affordable for commercial uses [Brandon Walton, 2015].

Solar energy is a renewable source of energy known as energy generated from the sun to produce heat and electricity. Solar energy absorbed energy and distribute using Solar Cells. The solar cell is known as photovoltaic cells. The photovoltaic cell is made up of semiconductor materials (silicon, found abundant in sand) and has the ability to convert the energy absorbed, i.e. sunlight is converted to electricity which is direct current (DC). These

cells are commonly found in spacecraft, the handheld calculator. These cells are connected to form modules, then panel and solar array.

Solar energy produces a clean source of energy and it is used and adopted over the years in some developed countries. For the solar energy to be used successfully, there are some electrical devices to be used such as solar panels, charge controller, inverter and cable and fuses, circuit breakers and batteries.

Solar panels: Several solar cells (photovoltaic cell) are connected together to form a solar panel. Depending on its size and the required energy, many solar panels can be combined to satisfy energy demand. The solar panel is the basis of every solar power system. The larger the solar panels, the more electricity is generated and solar panels also work best when kept cool, the hotter the panel, the less its power. Solar panel deals with brightness that is, a lot of daylight that falls on the panel, the more electricity is produced. If there's a shade on a panel, the electricity output falls greatly. There are 3 common types of solar panels.

1. Mono-crystalline panels: These panels are black with a sq. wafer with a cell potency of 15-25 %. It has a high cell potency
2. Polycrystalline panels: These panels are bluish and have an iridescent crystal look with 13-16% cell potency
3. Amorphous silicon also known as amorphous black features a consistent black surface with faintly visible lines and has the smallest cell potency of about 6-8%. Solar panel comes in varied sizes and power rates. The power outage of a solar panel can only be achieved under ideal conditions, that's once the sun has a radiated power of 1kilowatt/m² (at noontide, no clouds) and at a panel temperature of 25⁰C.

We need Ac to supply power to most of the electrical appliances found in homes and offices. Inverter has the ability to convert the DC current from Solar panels to Ac

Types of Inverters

1. Grid-Tie inverters: Grid-Tie inverter converts DC electricity from the solar array to AC electricity, which can be used to power up home appliances and others. It varies in sizes rated in KW to suite the power output from the solar panels. It only supplies electricity directly to the end user, but unable to charge batteries
 2. Battery inverters: Battery inverters also convert DC to AC and it's rated in KVA in different sizes and can also be able to charge batteries.
- Batteries: A solar panel produces electricity throughout the daytime once the sun is shining. The panel cannot store energy. If electricity is going to be required during the night, it must be stored. Thus batteries are introduced.

Common types include: lithium-ion batteries and lead-acid batteries.

1. Lithium-ion batteries: li-ion batteries are rechargeable batteries with a long life span 5-15 years and have high energy storage capacity and very expensive. Commonly found in high-end electronic equipment.
2. Lead-acid batteries: leads acid batteries are also rechargeable with a lifespan of 2 years to 10 years. There are common batteries used in solar energy system. Lead acid is classified into two criteria.

a. Usage/application (Starter and Deep cycle)

Starter battery is used to start cars or a car engine, it is not suitable for solar energy system

Deep cycle battery is majorly designed for solar energy system

b. Cell type (wet cell and dry cell)

Wet cell are commonly available type of battery, the acid in this battery are liquid and requires regular maintenance

Dry cells are called sealed batteries and the acid in this battery are in form of gel with maintenance free.

- Charge controller:
 - ✓ To charge the batteries safely, quickly and completely.
 - ✓ To protect the batteries from deep discharge, if the charge controller has a load controller function included.
 - ✓ To protect the batteries from overcharged.
 - ✓ To prevent reverse current from the batteries to the solar panel.

The charge controller regulates the power output from the solar panel array, which is used to charge the battery

There are two main technologies for charge controllers: Pulse width modulation (PWM) and Maximum PowerPoint tracking (MPP or MPPT)

- Electrical protective devices: which include Disconnect, fuses and breaker, lightning arrester/ earthing and combiner box.

Energy usage in Nigeria is split in two major categories: Industries (transportation, communication, commercial, agricultural, health, schools and so on) and households. To install solar energy system in a house or in an industry; load analysis must be carried out i.e. the load used in the industries and home before installing solar energy systems. Many household energy consuming includes lighting, cooking and use of any basic electrical appliances like Televisions, Air conditioners, fan, iron and so on. In industries, energy demands are very high compared to residential demand, the industries have different specifications and different energy demands.

These are the main components of the solar system, over the years solar power have been a source of generating electricity and can be adopted to enhance electricity for the country.

3.1 RESEARCH METHODOLOGY

Solar energy system consists of electrical devices with different functions. Once the daylight shines on the panels, energy is generated. The solar panels are connected to form solar array either parallel or in series depending on the energy demand to be generated, combine multiple wire from the solar panel (array) with few DC fuses or circuit breaker and also a disconnect switch can also be fixed from the solar panels to the charge controller; which regulates the energy output from the solar panels. Solar panels only produce electricity during the daylight, and it can be stored, to be used at night using Battery banks. Battery can also be connected in series and in parallel; therefore charge controller is connected to the batteries. The batteries produce only DC which can be converted. The batteries are connected to an inverter to produce an AC (mostly used at home and industries) and straightforward to the service box and energy is supply to the load and appliances at home. This is known as off- grid system.

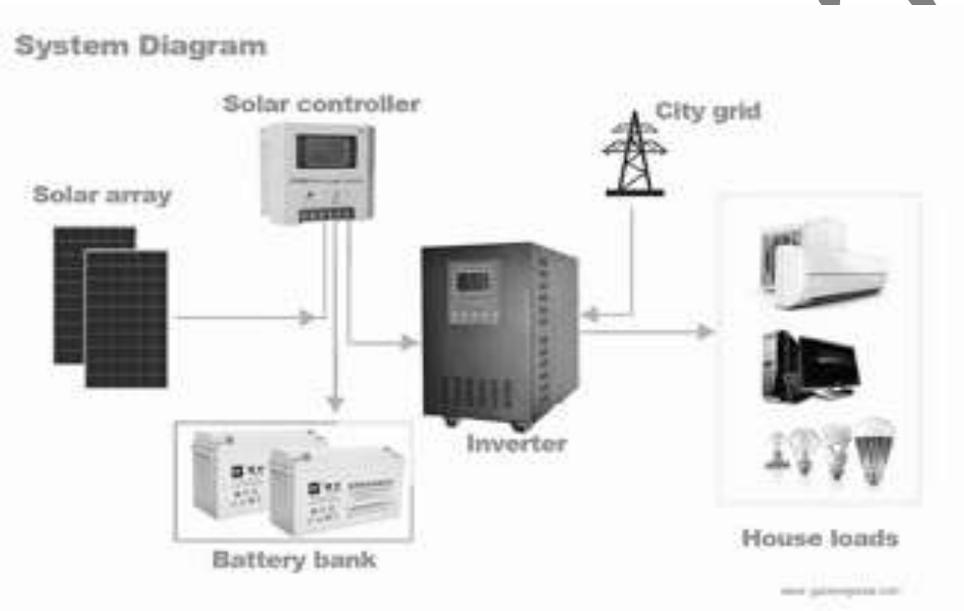


Figure 2

3.2 FACTS REGARDING SOLAR ENERGY SYSTEM

The following are some facts regarding solar energy system in connectedness to the present study

1. Solar energy is a renewable supply of energy that can be used as another supply of energy production.
2. Solar energy reduces the results of global warming i.e. harmful emissions discharge while producing electricity.
3. Solar energy produces clean source of energy
4. Solar energy features a low disbursal; it doesn't need fuel and has no variable prices
5. Solar creates Jobs such as solar energy installer, maintenance engineer etc and economic process for a rustic
6. Solar energy produces low price electricity for home and industrial uses

3.3 GENERAL OVERVIEW OF SOLAR ENERGY SYSTEM

Energy is important in every lives, worldwide electricity is used and essential to our day to day activities. Nigeria has not been able to achieve the supply of energy needs to the people. Lot of people spends a lot of money on fossil fuel daily to get power stable unfortunately energy is not stable. Solar energy is one of the renewable sources of energy which can produce adequate electricity supply to a country. Solar energy produces a clean source of energy that is suitable for household and even industrial needs. Solar energy can also serve as an alternative source of energy apart from hydropower. It does discharge any harmful emission while using and has no health risks (*Sunday olayinka, 2012*).

Considering the geographical location of Nigeria 9.0820⁰N 8.67530E (*Wikipedia 2015*). Nigeria is blessed with a good climax conditions, there's adequate sunlight all round in a year which can produce electricity for all Nigerians (*Sunday olayinka, 2012*). Solar energy can generate a large amount of energy annually of about 2 megawatts hour/m². Therefore having about 3000m² solar arrays, the amount of energy produces will be up to 60gigawatts annually. Nigeria the giants of Africa, endowed with different renewable resources that when developed and utilized will reduce the spread of economic recessions and eradicate poverty within country. Over the years, energy demand is more than the energy generated. At the tip of it all, we may regard energy as a relevant need to the Nigerian society of which this paper has highlighted solar technology as a measure provides an alternative solution.

3.4 LIMITATION OF STUDY

1. High cost of purchase and solar energy storage is expensive.
2. Political issues: The government in Nigeria is not encouraging the use of solar energy in the country.
3. Inadequate public notability about solar energy system and its energy generation.
4. Reliability of fossil fuel and hydropower

4.0 CONCLUSION

From the energy outlook of Nigeria, it is clear that energy demand increases while there's unreliable, inadequate power supply. Solar energy system has the greatest potential, helps in reductions of global warming and environmental hazard. Considering Nigeria climate conditions, solar energy system supports the basic needs of life such as cooking, suitable living temperature, lighting, communication, essential health care, the use of appliances and even transportation which can help the economy of the country and help in poverty eradication.

It is highly recommended that more attention should be given to renewable energy resources especially solar power. This will help to solve the problem of unreliable electricity and energy sector in Nigeria as solar energy system can serve as an alternative source of generating power.

NESTEC 2021

5.0 REFERENCES

1. Sunday, O.O. (2012). Energy and sustainable development in Nigeria: the way forward.
2. USAID, March 2017.
3. Wikipedia (2020). Solar energy in Africa
4. Brandon, W. (2015). A brief history of solar energy
5. Wikipedia (2020). Solar energy resources in USA and Europe
6. Smith, Zachary Alden; Taylor, Katrina D. (2008). Renewable and alternative energy resources
7. Ashok, S. (2015). Solar energy
8. Phillip, R. W. (2018). The solar generation
9. Taleb, A. (2012). Solar power system design
10. Christina, N. (2019). Renewable Energy
11. L.S.E. (2017). The five biggest solar markets in Africa
12. Samson, A.A. (2014). Energy growth and economic development: A case study of the Nigerian electricity sector