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Renewable Power Energy Production:The Energy Sustenance option for Nigeria

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Abstract
In Nigeria, as in many developing countries, providing energy to rural and urban areas has proved to be a great challenge. With increasing population, the pressures on the infrastructure for the supply of conventional energy resources will continue to increase. Economic growth, rapid industrialization and high standard of living of the global population demand more and more energy in different forms. Since the quantity of available energy from conventional resources shrinks day-by-day, development of newer or renewable energy technologies and improvement of conventional technologies become necessary to meet the energy demand in the future. The demand for energy in Nigeria can be met, or better still "subsidised" by this method as most of the demand from the National grid can be reduced considerably because several mega-watts of energy can be generated from renewable source. To this end the end-use forms of energy like electricity for both the improvements and development of technology becomes easily and readily available to all and sundry..
Keywords:- Renewable energy, solar, biomass, economic growth,, rural Nigeria

1.0 Introduction

Renewable energy is energy generated from natural resources—such as sunlight, wind, rain, tides and geothermal heat—which are renewable.

There have been rigorous efforts to meet the global energy demand challenges but relying on the traditional fossil fuels alone is synonymous to taken a great risk of backward trend in modern developmental strategies. The main reason behind this assertion is that fossil fuels and other conventional energy resources are not only limited but their global reserves is declining as each day closes. Excessive combustion of fossil fuel for energy has potential contribution to negative environmental consequences such as global warming. To this regard, renewable energy has attracted a very realistic global interest being the only viable option available to man for providing solution to energy.

An environmental concern over electric power generations from conventional sources has led to widespread public support for renewable energy sources. Governments throughout the world have responded by providing various forms of financial incentives to promote power generation from renewable energy sources.

To this regard, renewable energy has attracted a very realistic global interest being the only viable option available to man for providing solution to energy. Development of renewable energy from biomass is one of the major promising alternative energy resources because of its presence in almost every part of the world. The availability of sun, biomass, and wind in Nigeria makes it the most viable option to get the country out of this quagmire of epileptic power supply. This paper however, will discuss the solar and biomass option for Nigeria.

Renewable energy could provide as much as 35% of the world's energy needs by 2030, given the political will to promote its large scale deployment in all sectors on a global level, coupled with far reaching energy efficiency measures. This report stresses that the future of renewable energy development will strongly depend on political choices by both individual governments and the international community. By choosing renewable energy and energy efficiency, developing countries can virtually stabilise their CO_2 emissions, whilst at the same time increasing energy consumption through economic growth.

2.0 Aim

This paper intends to highlight a very practical information for decision makers in the country to develop rural - urban energy sector in Nigeria.

Though some of the technologies for these resources have been developed or domesticated but they are usually designed for meeting small isolated energy supply needs.

Most of the developing country have problem of highly inefficient Electricity Distribution Network. A suitable and efficient Renewable Energy technology will be the solution to this part of the world. This is because the abundance of wind (2 – 4m/s speed for upward of 17 hours) and solar power that ranges between (3.5 and 7.0

KWh/m^2/day^{-1}) and available for between 8 and 10.5 hours and energy of 442Mwe from biomass is possible in an average population of 16 million people (figures 1 and 2). This type of energy could be a visible solution that can be harnessed together ot singularly to deliver a majority of people from poverty.

This paper will try to discuss two renewable sources that are abundant in Nigeria. (Solar and Biomass) and develop them into a major energy source beyond domestic supplies.

There are a number of criteria which have to be considered, such as:

- availability of energy resources
- national and local economic conditions
- financing options and markets
- local and global environmental impacts
- employment and other social impacts
- technical capabilities and human resources
- institutional capacity

It is widely recognised that, for energy strategies to be sustainable, an approach is required which will combine all of these complex and interlinked aspects.

3.0 Objectives

The objective of this paper will be to highlight how to

- deliver Megawatt of energy into the national grid.
- develop a Renewable Energy information plan for Nigeria/third world countries and indeed African countries

4.0 Availability of energy resources

Due to the growing demand for power, we are facing a significant increase in society's expenditure on electricity supply. Under the reference scenario, the undiminished growth in demand, the increase in fossil fuel prices and the costs of CO2 emissions all result in electricity supply costs rising from today's $1,130 billion per year to more than $4,300 billion per year in 2050.

A scenario that not only complies with global CO2 reduction targets but also helps to stabilise energy costs and thus relieve the economic pressure on society should be developed. Increasing energy efficiency and shifting energy supply to renewable energy resources leads to long term costs for electricity supply that are one third lower than where we are at present. It becomes obvious that following stringent environmental targets in the energy sector also pays off in economic terms.

The obvious choice(s) is the renewable energy. Nigeria is divided politically into 6 geo-political zones. The country has abundance of solar energy with more been available in the northern part of the country. The Southern part however, is suitable for wind power - especially the coastal area that has well over 500 kilometers. The biomass is well distributed, as almost equally big cities exist in all the geo-political zones.

In this paper, emphases will be laid on Solar and biomass because of the readily availability in Nigeria.

5.0 Solar

The main source of easily accessible renewable energy is the sun. On average the rate of solar radiation intercepted by the earth's surface is about 8000 times as large as the average rate of world primary energy consumption. With the present world population this amounts to a staggering average power of 20 MW per person. In Nigeria, solar radiation intensities ranges from 3.5 to 7 0 KWhm–2day-1. The sunshine duration ranges 9.0 to 11.0 hours/day. On the average, the country has access to energy in excess of 3000 MW i.e. 3 GW daily from the sun.

The figure shows that this energy flux can be accessed directly using solar thermal or photovoltaic technology (see figures 1, 2, 3 4, etc), or indirectly in the form of wind, wave, hydro and biofuels.

A substantial proportion of the incident radiation is reflected back to space. Over the last several millennia and up to the onset of the industrial revolution, energy inputs and outputs have been in equilibrium at a global temperature level suitable for the development of the earth's biosphere. Exploiting the incident energy through the application of renewable energy technology *does not* disturb this balance. Intercepted natural energy flows, for example converted to electricity and then converted again by consumers into mechanical, chemical or light energy, all eventually degrade into heat.

Most renewable energy forms are readily converted to electricity. Solar energy, geothermal energy and biomass can also be used to supply heat. Renewable energy can in principal provide all the energy services available from conventional energy sources: heating, cooling, electricity and, albeit with some difficulty and cost, transport fuels. It has the additional advantage that being a naturally distributed resource, it can also provide energy to remote areas without the need for extensive energy transport systems. It is worth noting that it is not

always necessary to convert the renewable energy into electricity. Solar water heating and wind - powered water pumping are fine examples of systems that can work very well without involving electricity at all. However, the major contribution that renewable energy will be increasingly making in supplying people's needs will be in electrical form.

Two other energy sources are often regarded as renewable in view of their sustainable nature: energy in the tides caused by the gravitational fields of the moon and the sun which can be tapped using tidal barrages or tidal stream technology; and geothermal energy from the earth's core accessible in some locations through hot springs, geezers or boreholes. The available average power from these resources is a small fraction of that available from the sun.

How renewable energy of solar and/or biomass can benefit the rural populace in Nigeria albeit the third world are listed below

- Solar Chick Brooding
- Solar Refrigeration
- Improved Biomass Stoves
- Biogas Generation
- Solar PV technology
- Solar Drying
- Solar Water Purification
- Solar Air & Water Heating

5.1 Photovoltaics

A solar cell, or photovoltaic cell (PV), is a device that converts light into electric current using the photoelectric effect. The first solar cell was constructed by Charles Fritts in the 1880s. Although the prototype selenium cells converted less than 1% of incident light into electricity, both Ernst Werner von Siemens and James Clerk Maxwell recognized the importance of this discovery. Following the work of Russell Ohl in the 1940s, researchers Gerald Pearson, Calvin Fuller and Daryl Chapin created the silicon solar cell in 1954.[5] These early solar cells cost 286 USD/watt and reached efficiencies of 4.5–6%.[6]

The earliest significant application of solar cells was as a back-up power source to the Vanguard I satellite in 1958, which allowed it to continue transmitting for over a year after its chemical battery was exhausted. The successful operation of solar cells on this mission was duplicated in many other Soviet and American satellites, and by the late 1960s, PV had become the established source of power for them. Photovoltaics went on to play an essential part in the success of early commercial satellites such as Telstar, and they remain vital to the telecommunications infrastructure today.

The high cost of solar cells limited terrestrial uses throughout the 1960s. This changed in the early 1970s when prices reached levels that made PV generation competitive in remote areas without grid access. Early terrestrial uses included powering telecommunication stations, off-shore oil rigs, navigational buoys and railroad crossings. These off-grid applications have proven very successful and accounted for over half of worldwide installed capacity until 2004.

5.2 Concentrating solar power

Solar troughs are the most widely deployed and the most cost-effective CSP technology. Concentrated sunlight has been used to perform useful tasks since the time of ancient China. A legend claims that Archimedes used polished shields to concentrate sunlight on the invading Roman fleet and repel them from Syracuse. Auguste Mouchout used a parabolic trough to produce steam for the first solar steam engine in 1866, and subsequent developments led to the use of concentrating solar-powered devices for irrigation, refrigeration and locomotion.

Concentrating Solar Power (CSP) systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The concentrated light is then used as a heat source for a conventional power plant. A wide range of concentrating technologies exists; the most developed are the solar trough, parabolic dish and solar power tower. These methods vary in the way they track the Sun and focus light. In all these systems a working fluid is heated by the concentrated sunlight, and is then used for power generation or energy storage.

A parabolic dish system consists of a stand-alone parabolic reflector that concentrates light onto a receiver positioned at the reflector's focal point. The reflector tracks the Sun along two axes. Parabolic dish systems give the highest efficiency among CSP technologies. A 2.5 kW Big Dish is in use in some areas in Nigeria is an example of this technology.

6.0 Biomass:

The capture of solar energy as fixed carbon via photosynthesis is the key initial step in the biomass growing:
This can be expressed mathematically as

$$Co_2 + H_20 + \text{light} + \text{chlorophyll} \longrightarrow (CH_20) + O_2$$

In cities, daily human activities within domestic homes, commercial centers and industrial sites generate municipal solid waste (MSW) In Nigeria for instance; we have about 4 cities that generates high level and volume of waste. The cities are Lagos, Ibadan, Port Harcourt, Kano and Abuja. Other smaller ones include Benin City, Akure, Enugu etc.. These are densely populated cities in Nigeria with total population in excess of 50% of the total population of Nigeria. The burden of municipal solid waste management can certainly not be ignored in such a heavily populated metropolis. An effective way of managing the waste is to apply a logic that will provide economic and environmental advantages.

Municipal solid waste (MSW) is a composition of both organic and inorganic materials generated from series of human activities in industrial sites, domestic households, commercial centers and other institutional workshops. The presence of MSW in a society is a great problem if not well managed due to its ability to induce environmental degradation. In the past few years, the above Nigerian cities have witnessed rapid industrialization and demographic expansion. These twin developments have been responsible for the increase in volume of waste generations in these cities. This high quantity of waste generation symbolizes a greater opportunity for electricity generation in the form of alternative energy from bio-waste resource.

Organic fraction of municipal solid waste OFMSW is the most useful component of municipal solid waste. In advance nations, waste management is basically by land filling and combustion for energy in modern incineration or gasification systems. Among the industrialized nations, some countries developed policy framework for integrated waste management. An integrated waste management system is a management system, which ensured that all benefits that can be derived from MSW are effectively utilized.

In some countries, the organic fraction of the waste is treated by anaerobic digestion to produce biogas for fuel consumption. The traditional method of waste management in most developing countries is land filling and dumping in open areas. In majority of Africa countries, waste dumping in open areas is more prevalent. Waste management authorities of some organized cities in the region are more accustomed to land filling techniques for disposing their wastes while little is used for energy generation purpose. Due to high level of poverty in the region, human scavengers sometimes search for recyclables waste components in some open dump areas to make a living.

Like other bio-energy resources, OFMSW is biodegradable. The composition of MSW generated in Nigeria include but not limited to putrescibles, paper, plastic, textile waste, vegetables, metal glass and hospital waste. A solid waste is one of the new sources of energy called renewable energy. Wastes from different sources have different description as activities generating the wastes are differing. The content of industrial waste shows some variation from that of household and commercial wastes illustrates wastes from different sources. Major waste production in the metropolis comes from household activities, commercial, institutional and industrial operations.

6.1 How is biomass used to create energy?

Biomass energy systems can be based on a wide range of feedstock. They use many different conversion technologies to produce solid, liquid and gaseous fuels. These can then be used to provide heat, electricity and fuels to power vehicles; using burners, boilers, generators, internal combustion engines, turbines or fuel cells.
Power **c**an be generated by:

- co-firing a small portion of biomass on existing power plants;
- burning biomass in conventional steam boilers;
- biomass gasification; and
- anaerobic digestion.

Heat. The same power plants that produce power also yield useful steam and heat in combined heat and power (CHP). Biomass can be used in fireplaces and kilns to heat homes and at a bigger scale for "district heating".
Fuel. Unlike other renewable energy sources, biomass can be converted directly into liquid fuels for transport. The two most common biofuels are ethanol and biodiesel.

Recommendation

A renewable energy generator may be described either as *standalone* or *grid - connected* .In a standalone system a renewable energy generator (with or without other back - up generators or storage) supplies the greater part of the demand. In a grid - connected system, the renewable energy generator feeds power to a large interconnected grid, also fed by a variety of other generators. The crucial distinction here is that the power injected by the renewable energy generator is only a small fraction of that generated by the totality of generators on the grid. This paper for the case of Nigeria will recommend a stand-alone system
Also, the heat generated by the usage of oven and heating of water or other items can be saved when our attention shifts to bio-mass. The bio-mass will provide the fuel needed to generate the energy.
To make the energy [r]evolution real and to avoid dangerous climate change, the following assumptions need to be implemented:

- The phasing out of all subsidies for fossil fuels and nuclear energy and the internalisation of external costs
- The setting out of legally binding targets for renewable energy
- The provision of defined and stable returns for investors
- Guaranteed priority access to the grid for renewable generators
- Strict efficiency standards for all energy consuming appliances, buildings and vehicles

Conclusion

The desire of the world leaders to save the ozone layer by reducing the CO_2 emission within the next few years, places an enormous expectation on the development of Renewable Energy Technology (RET).

The domestic market consumes several MW of power. If a large amount of this power is however removed or replaced from external source from the convectional sources the remaining power will be enough to save the planet.

Renewable energy has a great role in achieving this and help rural developmental goal and also assist with a clear reduction of the CO_2 emission.

The environment will become better because of availability of cheaper and cleaner energy.

Finally the concept here is a project that will develop and deliver a viable and efficient system comprising of biomass, solar panel, (hybrid power energy) battery, converters/inverters, and synchronisers (same frequency) to deliver uninterrupted domestic power to the Distribution Network/household.

The concept in this paper is even to suggest a situation whereby most homes, street lights and power consumption in the little KW are powered by solar during the day thereby leaving the grid to supply the industries of the much needed electricity. One million houses in Nigeria using say, 1000W (i.e. a fan of 150W, TV of say 40W, fridge/freezer of 200W, 4 X 100W light in the parlour, etc.) of energy from the sun through solar panel has just saved the country 1000 MW. This amount will be available to the industries

Sunlight can be converted into electricity using photovoltaics (PV), concentrating solar power (CSP), and various experimental technologies. PV has mainly been used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array. For large-scale generation, CSP plants like SEGS have been the norm but recently multi-megawatt PV plants are becoming common. A repition of such in the tropics where sunlight are available for more than 10 hours will help to generate even over 300 MW in the south and more than 500 MW in the far north of Nigeria

As an intermittent energy source, solar power requires a backup supply, which can partially be complemented with local backup that is usually is done with batteries.

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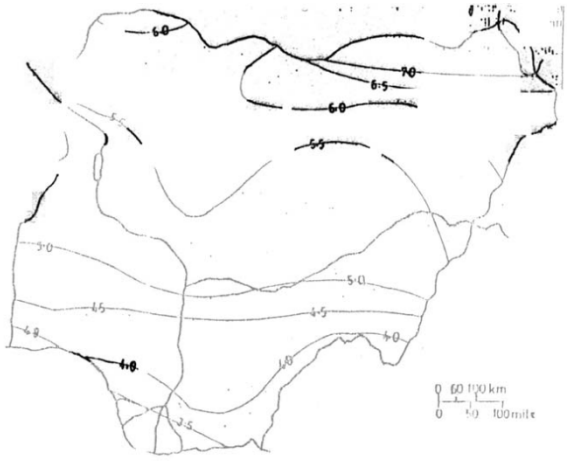

Fig 1. Annual Average of Daily Global Solar Radiation, kwh/m /day

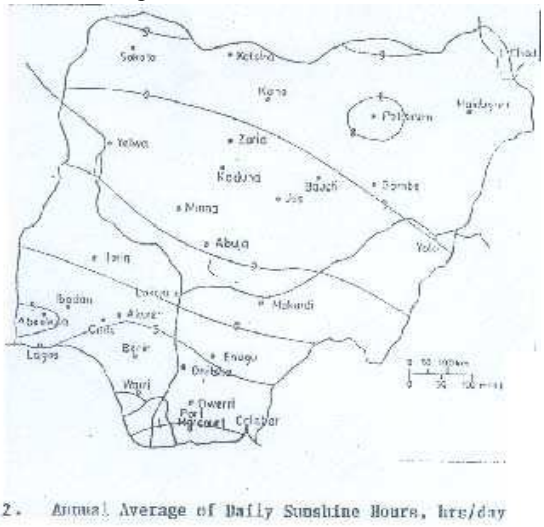

Fig 2. Annual Average of Daily Sunshine Hours, hrs/day

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