

A Review of Information and Communication Technologies Assisted Renewable Energy Technologies as a sine qua non for Solving Nigeria Energy Crisis

Regha, Israel Oghenevwede

Department of Computer Science

Federal College of Education

P.M.B 39 Kontagora, Nigeria

erebethel@yahoo.com

+2348036798412

Amah, Nnachi Lofty

Department of Computer Science

Federal College of Education

P.M.B 39 Kontagora, Nigeria

delofty2k@yahoo.com

+2348032527694

Abstract

Energy is fundamental to all human activities. The quest for industrial growth, policies and developmental visions of governments and institutions cannot be achieved without access to energy. Energy is inevitable for poverty alleviation and the production of goods and services. The economic potentials of developing nations is well recognized, and Nigeria as a country with considerable resource endowment and coastal location, there is potential for strong growth. Yet Nigeria has realized very little of this vast oil and natural potentials. The effect of unscheduled electricity blackouts and gas supply cuts in Nigeria gives a clear example of the problems facing the nation. The situation for energy adequacies is very pathetic and thus raising concern for an impossible foreseeable future solution. These and numerous economic uncertainties demand a review. This study is centered on sustainable energy systems and renewable energy resources. It also encapsulates the need, importance, options and impact of ICT driven renewable energy technologies as a prelude to solving Nigeria energy crisis.

Keywords: technologies, energy, renewable, education, innovation, security, development

INTRODUCTION

On the global front, there is need for energy, which will meet the requirements of today's increasing population and which will also adapt to the present capacity of industrializing and household consumption, stands before the danger of not being able to be supplied by the limited energy resources. Qurashi and Hussain (2007) emphasized that with lamentable lack of foresight, successive governments have exploited earth's non-renewable oil and gas reserves, and in so doing they have also, to some extent, poisoned the air we breathe.

Although the consequences are visible around us, from widespread poverty, unemployment, crime and economic slump. Poverty is widespread among Nigeria's 148 million inhabitants. In 1980, 28 per cent of the population was considered poor. Today, 71 per cent live on less than one dollar a day, while 92 per cent live on less than two dollars a day. About 60 per cent of Nigeria's population has no access to electricity (90 per cent in rural areas). People need power for lighting (e.g. for evening study); household appliances; irrigation pumps; health clinics (e.g. vaccine refrigeration); food and agricultural processing (e.g. cassava driers and rice mills); and transport fuel. Small-scale traders, manufacturers and crafts people also require power for small-scale machinery, such as sewing machines. This lack of access to efficient energy resources has had adverse impacts on manufacturing, commerce, industry, agriculture, education etc (UNDP 2009).

As a country with vast oil and gas reserves, abundant sunlight and significant hydropower potential, Nigeria should not be suffering an energy crisis. The energy sector is characterized by missed opportunities and wastage due to poor regulation, lack of maintenance, entrenched corruption, political bigotry and escalating insurgent activities. Inadequate power generation and transmission and limited access to the national grid are persistent problems for nearly every Nigerian.

By the growth of the shortfall between production and consumption of energy, and environment pollutant characteristics of the traditional energy production methods, in addition to the fact that these energy sources will come to an end have all added up to the requirement of investigating alternative energy resources.

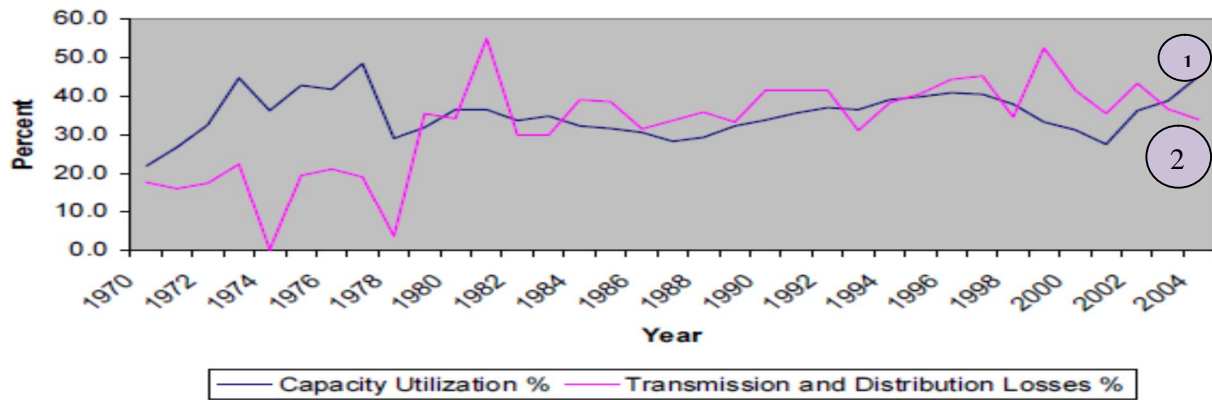
OVERVIEW OF NIGERIA ENERGY SITUATION

Energy is the mainstay of Nigeria's economic growth and development. It plays a significant role in the nation's international diplomacy and it serves as a tradable commodity for earning the national income, which is used to support government development programmes. It also serves as an input into the production of goods and services in the nation's industry, transport, agriculture, health and education sectors, as well as an instrument for politics, security.

Sambo (2009) stated that energy, and in particular oil and gas, has continued to contribute over 70% of Nigeria's Federal revenue. National developmental programmes, and security, depend largely on these revenue earnings. The energy sub-sector, especially petroleum, continues to maintain its prominence as the single most important source of government revenue and foreign exchange earner. Petroleum contributed an average 25.24% to the GDP between 2002 and 2006. However, despite the fortunes of the oil sector, other sectors of the economy are declining.

An excerpt from Energy Commission of Nigeria shows that consumption of electricity actually declined by 13.4% between 2002 and 2006 even though the overall or total electricity consumption showed a marginal increase of 1.8% from 5.63GWh in 2002 to 7.47GWh in 2006. Only about 40%

of households in Nigeria are connected to the national grid. There is high-energy loss due to the physical deterioration of the transmission and distribution facilities, an inadequate and falsified metering system and an increase in the incidence of power theft through illegal connections. The figure below is a clear indication of an increase in energy transmission and distribution losses from 1970 to 2004.



Source: PHCN (2006)

Other problems as identified by Sambo (2009) of the power sector, includes manpower constraints and inadequate support facilities, the high cost of electricity production, poor distribution network, inadequate basic industries to service the power sector, poor billing systems, poor settlements of bills by consumers (consumers` behavior) and low available capacity.

The situation in the rural areas of the country is that most end users depend on fuel wood. Fuel wood is used by over 70% of Nigerians living in the rural areas. Nigeria consumes over 50 million metric tonnes of fuel wood annually, a rate, which exceeds the replenishment rate through various afforestation programmes. Sourcing fuel wood for domestic and commercial uses is a major cause of desertification in the arid-zone states and erosion in the southern part of the country. The rate of deforestation is about 350,000 hectares per year, which is equivalent to 3.6% of the present area of forests and woodlands, whereas reforestation is only at about 10% of the deforestation rate.

Meanwhile electricity is required for such basic developmental services as pipe borne water, health care, telecommunications and quality education. The poverty eradication and Universal Basic Education (UBE) programmes require energy for success. The absence of reliable energy supply has not only left the rural populace socially backward but has left their economic potentials untapped.

Fortunately, Nigeria is blessed with abundant renewable energy resources such as solar, wind, biomass and small hydropower potentials. The logical solution is increased penetration of renewables into the energy supply mix. The rest of this article contains some of the modest progress made in the promotion of renewable energy technologies in Nigeria towards ensuring sustainable energy development.

SCIENCE EDUCATION AND RENEWABLE ENERGY TECHNOLOGIES INNOVATION

In a rapidly-evolving world, science and technology education is an important instrument in the search for sustainable development and poverty reduction. Science educations have been able to adapt to current scientific and technological developments. According to UNESCO (2010), Science and Technology Education promotes a multi-disciplinary approach to the development of new and emerging technologies and gives particular attention to the provision of basic knowledge, life skills and scientific literacy for all, as well as preparation for the world of work.

RENEWABLE ENERGY AS ALTERNATIVE ENERGY SOLUTION

According to American Council on Renewable Energy (ACORE, 2007), Renewable energy is described as energy that is derived from resources that are continually available. And their use or capture does not inflict any material damage on the environment. Energy which comes from natural resources such as sunlight, wind, rain, tides, biofuels and geothermal heat, which are renewable (naturally replenished). Renewable energy is alternative to the persistent energy crisis because of its human and environmental friendliness to meet the energy needs of the present without compromising on the ability of the future generations to meet their own need.

Associated Benefits of Renewable Energy

Finding reliable sources of renewable energy is important in order to help slow the effects of global warming and to reduce the need for fossil fuels. There are also other advantages to using renewable energy to replace the burning of fossil fuels. Some of the biggest advantages of using renewable energy are:

- i. Renewable energy will never be depleted – No matter how much energy is needed by people all over the world and in Nigeria, renewable energy sources will never run out and can continue to make electricity and heat as long as there are people that need them.
- ii. Renewable energy helps the environment – This chiefly comes from producing fewer greenhouse gases that contribute to global warming. In addition to slowing down the effects of global warming using renewable energy sources also helps preserve ecosystems that would be destroyed to develop the fossil fuels found in the land. When there are fewer pollutants in the air the plants and trees that make oxygen will be healthier and will put out more oxygen which will make people healthier.
- iii. Renewable energy is safer than fossil fuel – Fossil fuels used to create heat and electricity and as fuel for vehicles creates toxic chemicals that are released into the air and lead to bad air quality and acid rain. Everything that is alive is affected by that kind of pollution including humans. Renewable energy sources greatly reduce or even eliminate pollution of the air and water. With less pollution in the air and water people will be healthier and won't be at risk of health problems caused by pollution like asthma and other respiratory problems.
- iv. Renewable energy sources create jobs and industry – Since renewable energy sources require specialized equipment and lots of research, the business of creating renewable energy sources that are accessible to lots of people means that there will be a lot of new businesses and a lot of new jobs for people.

- v. Renewable energy means cheaper energy – When countries depend on renewable energy sources instead of foreign fossil fuels, the cost of renewable energy will go down making electricity and heat more affordable for low income earners.
- vi. Renewable energies are easy to conserve, maintain and secure, thereby increasing energy availability and efficiency.
- vii. Renewable energy also offers a chance for increased economic development. This is especially true for people who in the past have been struggling to make a living like farmers that grow grain and plants that can be used for bio energy.

Sources of Renewable Energy

Several renewable energy sources exist. The following are the renewable energy sources

Solar energy

The sun will always be there, and in abundance - the amount of solar energy intercepted by the Earth every minute is greater than the amount of energy the world uses in fossil fuels each year. Solar energy is the energy derived from the sun through the form of solar radiation. Solar powered electrical generation relies on photovoltaic and heat engines. A partial list of other solar applications includes space heating and cooling through solar architecture, day lighting, solar hot water, solar cooking, and high temperature process heat for industrial and domestic purposes.

Wind Energy

The wind will always exist - The energy in the winds that blow across the United States each year could produce more than 16 billion GJ of electricity - more than one and one-half times the electricity consumed in the United States in 2000 (Wikipedia, the free encyclopedia, 2010).

Hydroelectric Energy

This is a term usually reserved for large-scale hydroelectric dams. Unless there is a drastic change in rain patterns, it will always be there. Energy is a term usually reserved for large-scale hydroelectric dams

Biomass

Biomass energy is obtained by converting animal, plant and agricultural waste to useful fuels, which is renewable, environment-friendly and a sustainable source. Through the process of photosynthesis, plants capture the sun's energy. When the plants are burned, they release the sun's energy they contain. In this way, biomass functions as a sort of natural battery for storing solar energy. As long as biomass is produced sustainably, with only as much used as is grown, the battery will last indefinitely.

Ocean

This is an emerging renewable technology that generates electrical power from ocean waves and has been gaining momentum as a viable technology. This includes marine current power, ocean thermal energy conversion, and tidal power.

Geothermal sources

Geothermal energy is energy obtained by tapping the heat of the earth itself, both from kilometers deep into the Earth's crust and hot dry rocks'

Biofuels

Liquid biofuel is usually either bioalcohol such as bioethanol or an oil such as biodiesel. It is made from sugar, starch crops, vegetable oils and animal fats

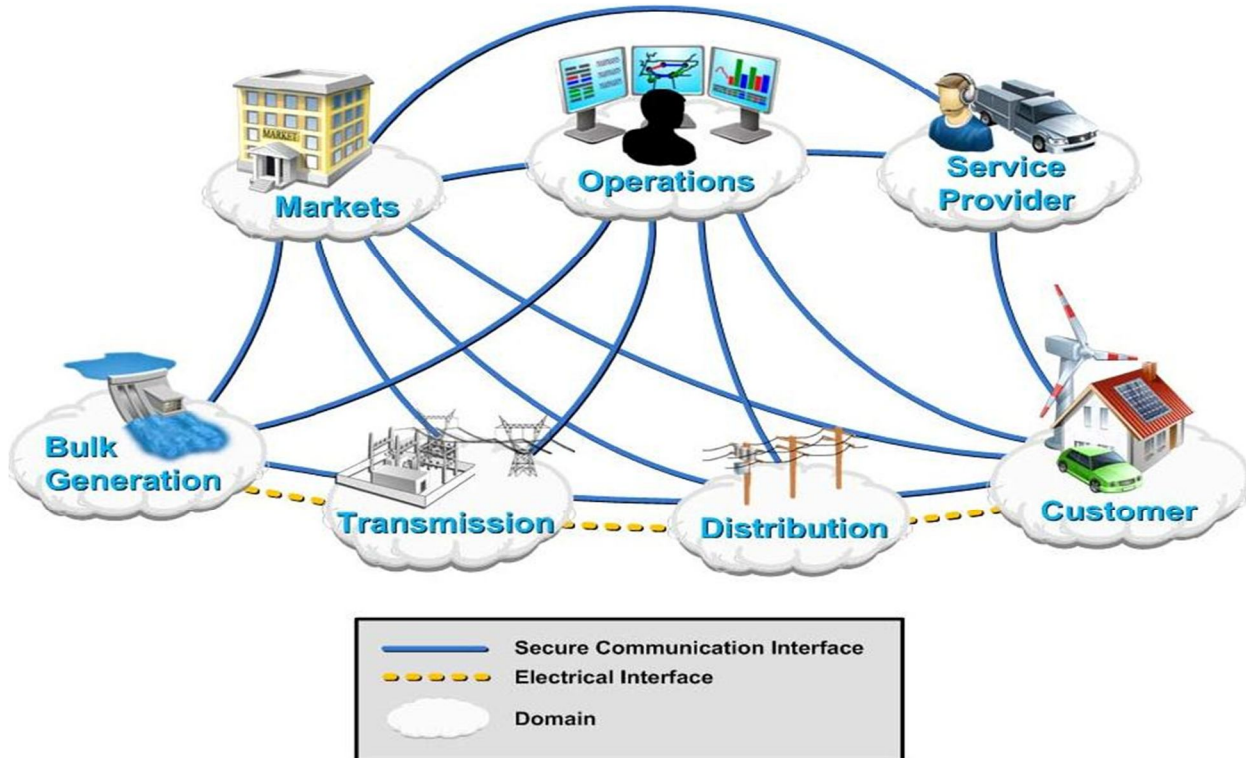
ICT ASSISTED ENERGY EFFICIENCY AND SECURITY

Many renewable energy sources are inferior and are in low quantity. In solving the Nigeria energy problem, another biggest challenge will be to integrate the renewable energy sources to the national distribution grid to serve large population of end users. We must not forget to equate the relationship between production and distribution and the ever increasing consumers controlling factors.

Presently, the distribution networks do not have the capacity to handle energy demand shift and because the infrastructure is inflexible, rapid transformation to meet the changes is not feasible.

This is where ICT will come into play in improving efficiency of energy distribution throughout the country. ICT can put active management on what happens in the low-voltage network and actually controls the network. The introduction and implementation of ICT on a new scale that has not been seen before, starting with the "Smart meters" on the consumer end and moving up to the network will provide relieve to the crisis driven energy production and consumption. ICT offers clear advantage of balancing between supply and demand with considerably more accuracy; It allows, through measurements, to pinpoint exactly where the fault is in case of incident (power outage). The figure below shows a conceptual model of ICTs assisted energy transmission, security and efficiency.

A Conceptual Model of ICT Assisted Energy Efficiency



Source: Derek (2010)

This technological analysis can be applicable in the present Nigeria energy generation and distribution.

INTELLIGENT ENERGY TECHNOLOGIES AND ENERGY NETWORKS OF THE FUTURE

Other intelligent energy technologies have been identified with the capabilities to integrate the renewable energy sources in the national distribution grid. These are:

The eTelligence

The “eTelligence” is an intelligent system integrating electricity generation (from renewable) and consumption using modern ICT. The aim is to develop a regional electricity market place, with different tariffs, incentive programs as well as a control system for consumers.

The “eTelligence” if introduced in Nigeria will bring together producers (solar cells, wind mills, biomass, geothermal station, ocean wave, etc.), consumers, energy service providers, and network operators on a regional market. For instance, a very good prediction of the wind has to be feed into the system to manage the energy supply. Using ICT and international standards, a Plug & Play IT infrastructure for communication with producers and consumers is implemented. The integration of these systems allows for the automated control of producers and consumers. The intentions of the

“eTelligence” system are cost-effectiveness and energy efficiency in the operation of huge network and more information to consumers so they can save energy and money.

The use of information and communication technologies (ICTs) and novel intelligent optimization algorithms that control connected units are the basis of 'smart' grid operation. These intelligent technologies aim at aggregating various renewable energy sources (such as wind turbines, photovoltaic (PV) and biomass plants), consumers (residential and commercial) and storage (electrical vehicles and a pumped hydropower plant) in a virtual power plant.

The Smart Technologies

This comprises of the Smart grid and the smart meters and their description are given below:

Smart Grid

A smart grid includes an intelligent monitoring system that keeps track of all electricity flowing in the station. A smart grid delivers electricity from suppliers to consumers using two-way digital technology to control appliances at consumers' homes to save energy, reduce cost and increase reliability and transparency (Wikipedia, 2009).

Such a modernized electricity network is being promoted by many governments as a way of addressing energy independence, global warming and emergency resilience issues. Smart meters may be part of a smart grid, but alone do not constitute a smart grid. Many renewable energy sources are inferior to conventional power stations with regard to planning and controlling energy generation. Generation by wind turbines or photovoltaic systems in particular can lead to major fluctuations in the energy supplied to the power grid. Such fluctuations (and other allocation irregularities) sometimes even lead to negative energy prices.

Smart Meter

A smart meter, according to regulatory authorities, is an advanced meter (usually an electrical meter) that records consumption in intervals of an hour or less and communicates that information at least daily via some communications network back to the utility for monitoring and billing purposes.

Emphasis is placed on energy efficiency which can produce a win-win for any economy and climate, and that smart government policy can catalyze the energy efficiency benefits of ICT—from the smart grid, smart manufacturing, dynamic building energy management, and optimized data centers, to smart transportation and tele-network.

The study, called SMART2020, shows that ICT can have a pivotal role in monitoring, optimizing and managing the energy efficiency of domestic and industrial energy usage. The traditional energy networks are hierarchical: there is a “central” production (generally on a scale measured in hundreds and thousands of Megawatts), there is a transmission at extra high voltage to the regions (usually meshed for easy balance of supply and demand), and there is a distribution within the region at medium and low voltage to consumers (usually star networks for easy energy distribution) Partners Green (2006).

Fortunately, recent advances in areas such as networking, embedded systems, construction automation, and ubiquitous computing can complement conventional ICT in this respect. Similar future proposals include smart electric grid, smart power grid, intelligent grid (or intelligrid), FutureGrid, and the more modern intergrid and intragrid

CONCLUSION

Given the serious problems faced by the oil and gas industries in Nigeria from generation to distribution, and knowing too well that the fossil energy will one day become exhausted. It is now time we really begin looking towards alternative energy sources. States should develop their own energy resource based on the availability of the renewable raw resources around them.

Mother Science, Technology and Mathematics Education become a breakthrough because of her particular attention to the provision of basic knowledge, life skills and scientific literacy for all, as well as preparation for the world of work. It is no more a myth that the silver-bullet to fight and overcome the danger and threats from energy crisis on the Nigeria economy and the well being of her population is the renewable technologies powered by Information and Communication Technologies.

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