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WATER AND ENERGY RESOURCES: DEVELOPMENT FOR RENEWABLE ENERGY IN NIGERIA

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ABSTRACT

Nigeria is well endowed with abundant natural water, renewable and non-renewable energy resources to harness with view to diversify its energy supply and meet the demand of its growing population. There has been a supply-demand gap, as a result of inadequate development and inefficient management of the energy sector. The availability and consumption of energy in the life of a country are an index of prosperity. However, Nigeria with the high potentials and strong resource base for both renewable and non-renewable energy reserve is lagged behind in meeting its national requirement for usable energy needs. This paper examined the potentialities of energy resources that with appropriate plans, Nigeria could harness its waters and energy resources for economic development and achieve food security goal effectively. If these energy resources are sustainably managed to improve the energy balance of electric energy power scarcity experienced in the country. Nigeria could achieve rapid development in many sectors. This paper examined the various forms of energy sources and how they can be utilized for national development. It is recommended that legislations and laws should be put in place to the guide the establishment of the of the renewable energy industry in order to protect the interest of the environment, existing communities and the investors alike.

Keywords: Water; energy sources; renewable energy

INTRODUCTION

Currently fossil energy expenditure is directly related to many factors, including rapid population growth, urbanization, and high per capita consumption rates. Indeed, energy use has been growing even faster than world population growth (Ogbonnaya *et al.*, 2007). From 1990 – 1995, energy use was increasing at a rate of 2.5% per year (doubling every 30 years) whereas the world population only grew at 1.7% (doubling about 40 years) (PRB, 1996). From 1995-2015, energy use is projected to increase at a rate 2.2% (doubling every 32 years) compared with a population rate 1.5% (doubling every 47 years PRB, 1996) (Pimental *et al.*, 1998; Anonymous, 2008; PRB, 2012; PRB, 2015). This means that demand for energy to household, industries, agriculture and other sectors would equally increase globally. In the same manner, Ibitoye and Adenikinju (2007); Ohunakin (2010); and Anon (2015) recorded that current energy demand stands at 6500MW to over 160 GW in AD 2030. This level of supply would be significant to increase the per capita electricity consumption to about 5000

Kwh per capita by year 2030. In this regard, full exploitation and promotion of the non renewable and the renewable sources of energy will provide a most efficient and effective means of achieving sustainable energy development in Nigeria.

Energy, it is an essential ingredient for socio-economic development and economic growth. The objective of the energy system is to provide energy services. Energy services are the desired products, processes or indeed services that result from the use of energy, such as for lighting, provision of air-conditioned indoor climate, agriculture, refrigerated storage, transportation, appropriate temperatures for cooking, etc. The energy chain to deliver these cited services begins with the collection or extraction of primary energy, which is then converted into energy carriers suitable for various end-uses (Ezannaya *et al*., 2014). These energy carriers are used in energy end-use technologies to provide the desired energy services (Ohnakin, 2010). Nigeria is blessed with abundant resources of fossil fuels as well as renewable energy sources.

Renewable energies include wind, ocean wave and tides, solar, biomass, rivers, geothermal (heat of the earth), etc. They are 'renewable' because they are regularly replenished by natural processes and are therefore in endless supply. They also can operate without polluting the environment. Technologies have been developed to harness these energies and such technologies are called Renewable Energy Technologies (RETs) or sometimes also called "clean technologies" or "green energy". Because renewable energy are constantly being replenished from natural sources, they have security of supply, unlike fossil fuels, which are negotiated on the international market and subject to international competition, sometimes may even result in wars and shortages, in addition to increasing the greenhouse emission, high cost of processing (Sunday, 2012). This has provided an incentive to seek for alternative sources (Highina *et al.,* 2011). They have important advantages which could be stated as follows. Their rate of use will not affect their availability in the future; thus, they are inexhaustible. The resources are generally well distributed all over the world, even though the wide spatial and temporal variations occur. Thus, all regions of the world have reasonable access to one or more forms of renewable energy supply. They are clean and pollution-free, and therefore a sustainable natural form of energy. They can be cheaply and continuously harvested and therefore a sustainable source of energy (Sunday, 2012)). Unlike the nuclear and fossil fuel plants, which belong to big companies, governments or state owned enterprises, renewable energy can be set up in small units and is therefore suitable for community management and ownership.

Currently a high proportion of the world's total energy output is generated from fossil fuels such as oil and coal. In general, the quest for an option to conventional power schemes for extension to remote and rural locations of developing countries like Nigeria arises from the high costs associated with the extensions, as well as the maintenance of the power grid system to rural areas. The costs of grid extensions will vary widely from country to country and will be heavily dependent on the system used, the length of connection required, type of topography, the usage pattern and the load factor of the supply point (Charters, 1985; Wolde, 2005; Ibitoye and Adenike 2007). More specifically, the close relationship between the proximity of energy resources to the potential users coupled with the high cost of conventional energy sources have led to a considerable interest in the development and application of renewable energy resources. Although research and development activities such as new technologies that reduce wastage and save cost, energy efficiencies practices and application of energy conservation measures are still being seriously undertaken in various aspects of renewable energy utilizations, a number of the technologies have since been shown

to be feasible and ready for adoption into the economy. These technologies are very suitable for the rural areas of Nigeria (Sambo, 2005; Sunday, 2012).

Energy Status in Nigeria

Nigeria, with a rural population of over 60% -70% does not have access to electricity, the centralized energy system exists (Sunday, 2012). The country has been solely dependent on the exploitation of oil to meet its development expenditure. It plays a significant role in the nation's international diplomacy and it serves as tradable commodity for earning the national income, which supports 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 and diplomacy (Ezannaya *et al.*, 2014). Nigeria is the sixth largest crude oil exporter and a leading gas exporter with crude oil reserve of over 36 billion barrels yet the nation suffers enormous energy crisis manifesting in various forms: about 60 -70 % of the nation's population is excluded from the national electricity grid. Moreover, the grid has been plagued by rather frequent power outages that last for several hours daily in places that are connected to the grid. Still, the grid electrical energy is generated from unsustainable sources (large hydropower stations and a growing number of thermal gas stations).

Over 60% of the country's population depends on fuelwood for cooking and other domestic uses (Yakubu, 2006). The consumption of fuelwood is worsened by the use of inefficient cookstoves, which have very low thermal efficiency and produce smoke hazardous to human health. Increasing fuelwood consumption contributes to deforestation leading to desertification and soil erosion. Women and children are most affected, making them vulnerable to respiratory disorders and other adverse health conditions. This lack of access to efficient resources has had adverse impacts on manufacturing, commerce, industries and agriculture, etc. Agriculture has not developed beyond the small holder subsistent level, as farmers cannot increase production without energy, while harvests are mostly lost due to lack of storage. Producers and farmers are left with dwindling options. Artisans, small scale enterprises and larger productive enterprises are collapsing due to lack of accessible electricity. The overall result is the loss of jobs and the impoverishment of many (Ileoje, 2004; Sambo, 2006; Anon, 2008; Anon, 2015). It has been observed that Nigeria's per capita electricity consumption is very low as the country lags behind other African countries in providing energy access to its citizens. Electricity generation is put at about 20 watts per person (Ogbonnaya, *et al*., 2007). Indeed Nigeria's per capita energy consumption is 4 times less than the African average and about 19 times less than the world average (Sambo, 2009). The World Conventional Energy Supply in 2004 showed Africa's highest supply in descending order of magnitude as follows: South Africa - 30,020MW; Egypt -14,250MW; Algeria - 6,188MW; Libya - 4,710 MW; Morocco - 3,592 MW, and Nigeria- 3,500MW (Uduma,2007).But between 2005 and 2009, power generating capacity in Nigeria oscillated between 2,600MW and 3,000MW (Anon, 2008). This means that the 44.3 million members of South Africa's population have electricity 12 times more than the over 140 million Nigerians. Egypt, which is second with a 14,250 MW capacity and a population of about 77.5 million is approximately 6 times higher than Nigeria in conventional energy output. The costliest energy need in Nigeria is lighting - similar to the pattern in other African countries where nearly 10-15 percent of the poorest household income may be spent on kerosene lamps, stoves or candles (Sambo, 2009). The case is not different in Nigeria, where the

poorest households earn about 1-2 US dollars per day and spend about 0.4 dollars per day on energy needs. Kerosene lamps provide poor lighting and are expensive, inefficient, highly polluting and dangerous. Data obtained from Energy Commission of Nigeria showed that current power generation is a far cry from national requirement, which is put at 31,210 MW at an optistic GDP growth rate of 11.5%. This unfortunate situation has brought to force, the need to explore alternatives to close wide gap between demand for and supply of energy services in Nigeria (Anon, 2015).

Irrigation/water- cum- Hydro-energy

The availability of adequate water supplies has an impact on the availability of energy supplied. Energy production and generation activities affect the availability and quality of the water supplied. In today's economies, energy and water are linked, each requires the other. As these two resources, see increasing demand and the growing limitations on supply, energy and water must begin to be managed together to maintain reliable energy and water supplies. The interaction of energy and water supplies and infrastructures is becoming clearer. Energy, water and agriculture issues are inexorable bound together. Energy production is a major user of water, as well as water is essential to the supply of energy (Anonymous, 2010). Water and energy are two highly interconnected sectors, but at present these linkages are not fully taken into account in policy making in Nigeria. In the context of the fast growing population and economic development leading to increasing demands and competition for water and energy. It is time to adopt an integrated approach to the management of water to serve both energy and agricultural needs. Agriculture is a key sector where spill over of energy production and consumption are pronounced (Charlotte, *et al.*, 2004). Accelerating access to energy for the rural poor offers new opportunity for agriculture, including access to cheap sources of energy.

To meet the basic food needs of expanding human population a productive, sustainable agricultural system must become a major priority. Modern agriculture is heavily dependent on non-renewable energy sources, especially petroleum. The continued use of these energy sources cannot be sustained indefinitely, yet to abruptly abandon our reliance on them would be economically unproductive. However, a sudden cut off in energy supply would be equally disruptive. In sustainable agricultural systems, there is reduced reliance on non-renewable energy sources and a substitution of renewable sources or labour to the extent that is economically feasible (Gail *et al.*, 2009).

Nigeria, been a developing country with high population, is in dire need for more energy sources to cater for the demand of energy for agriculture and other sectors of the economy (Mac-Anthony,2010). With the increasing population, the pressures on the infrastructure for the supply of conventional energy resources continue to increase. Again, conventional energy is depletable with extinction risk. In order to enhance the energy, food security of the country, and establish sustainable energy supply system, it is necessary to promote the policy of diversifying the energy supply system so as to include alternative or renewable sources and technologies in to the nation's energy supply mix (Highina *et al.*, 2011; Ezannaya *et al.*, 2014). The country is highly endowed with sources of energy and water resources. The energy resources both fossil and renewable (wind, solar, geothermal, water, large/small hydro and biomass (crops) remains largely untapped (Okafor and Joe-Uzuegbu, 2010; Sunday, 2012). Agricultural sources of energy are the emerging development of biofuels, both the first and second generations are quite available due to the

good climatic variation suitable for production of these crops (Anoymous, 2 011; Nnaji *et al.*, 2010). Integrating these two sources (energy and water) will empower Nigeria in a domain of energy world significantly. Therefore, planning the water resources in the area of development and use of existing dams to generate more energy as hydropower, and irrigation facilities for production of biofuels and food is imperative, which have minimal or zero supply logistics problems. Harnessing these resources leads to decentralized use and local implementation and management, thereby making sustainable rural socio-economic development possible through self-reliance and the use of local natural resources (Salami and Sule, 2012). For this to happen the policy makers should make renewable energy development a priority policy statement of government at all levels (Mustapha and Yusuf, 2012). Therefore, this paper seeks to justify that Nigeria, with appropriate plans of its water and energy resources could be harnessed to diversify the energy base, and food security status for economic, and development growth.

Renewable Energy (RE)

According to the World Council for Renewable Energy (WCRE), the Renewable Energy gotten from non-fossil and non-nuclear sources in replenishing means that its collection, conversion and utilization occur in a sustainable manner that does not have negative impact on the productivity and rights of local communities and natural ecosystems (Anon,2008). The production and provision of electric power from renewable energy sources is the new global focus with massive advocacy for increased investment in the Research and Development (R&D) of Renewable Energy (RE) technologies. The government of Nigeria has done very little to suggest an understanding of the need for action on developing renewable. The National Energy Policy on Renewable Energy provides for the development and harnessing of the RE resources of the country and the use of same to promote decentralized energy supply. The development and promotion of RE technologies in the country today are the responsibility of the Energy Commission of Nigeria. It is expected that the Commission will use Renewable Energy or Variable Output Technologies to pursue environmental sustainability agenda. Sadly, inadequate funding has affected the few RE trainings, information dissemination, pilot and demonstration projects that the Energy Commission of Nigeria embarked upon in the past few years. The result is that we are still where we were in RE advancement before the Commission was established. A review of Nigeria's grossly under-utilized Renewable Energy resources, in terms of its potentials, capacity, and development reveal an abundance of resources that can be harnessed to make Nigeria one of the most industrialized countries in the world (ECN, 2015).

Water Resources

Water is an integral element of energy resource development and utilization. It is used in energy-resource extraction, refining and processing, and transportation. Water is also an integral part of electric-power generation. It is used directly in hydroelectric generation and is also used extensively for cooling and emissions scrubbing in thermo-electric generation. Nigeria's total renewable water resources are estimated to be in the order of 280 km^3/year (FAO, 1995; 1997). The internal renewable water resources are estimated at 221km^3/year, of which 87km^3/year are groundwater resources. Some 80km^3/year of the groundwater resources is river base flows. There are some substantial trans-border flows, though figures

are not fully consistent, contributing to renewable water resources. Between 18 and 30km^3/year enters Nigeria via the Niger River from Niger, and another 13.5-29km^3/year are contributed by Cameroon feeding into the Benue river system. Outflow to the sea is estimated as 177km^3/year (Hundertmark, 2000; Mustapha and Yusuf, 2012). This water resource if aptly managed would support both small and large scale dams for irrigation of food and biofuel crops and hydropower generation. Both hydropower and biomass require substantial amount of water. Hydropower is largely non consumptive water user, though there are some loses due to evaporation from reservoirs and timing of releases may conflict with other consumptive use (Agunwamba, 2000; Salami and Sule 2012). Hydropower to supply energy via turbines and biomass production (biofuels) with irrigation farming will expand foods and biofuel crops for security of food and energy.

Hydro Energy Potentials of Nigeria

Essentially, hydropower systems rely on the potential energy difference between the levels of water in reservoirs, dams or lakes and their discharge tail water levels downstream. The water turbines which convert the potential energy of water to shaft rotation are coupled to suitable generators. The hydropower potential of Nigeria is very high and hydropower currently accounts for about 29% of the total electrical power supply. The first hydropower supply station in Nigeria is at Kainji on the river Niger, where the installed capacity is 836MW with provisions for expansion to 1156MW. A second hydropower station in the Niger is at Jebba with an installed capacity of 540 MW. An estimation by Aliyu and Elegba (1990) for rivers Kaduna, Benue and Cross River (at Shiroro, Makurdi and Ikom, respectively) indicates their total capacity to stand at about 4,650 MW. Estimates for the rivers on the Mambila Plateau are put at 2,330MW. The overall hydropower resources potentially exploitable in Nigeria are in excess of 11,000MW. The foregoing assessment is for large hydro schemes which have predominantly been the class of schemes in use prior to the oil crisis of 1973. Since that time, however, many developed and developing countries have opted for small scale hydropower with appreciable savings made over the otherwise alternative of crude oil. It should be noted that hydropower plants that supply electrical energy between the range of 15kW to 15MW are mini-hydro while those supplying below 15kW are normally referred to as micro-hydro plants (Sambo and Taylor, 1990). Indeed small-scale (both micro and mini) hydropower systems possess the advantage, over large hydro systems, that problems of topography are not excessive. In effect, small hydropower systems can be setup in all parts of the country so that the potential energy in the large network of rivers can be tapped and converted to electrical energy. In this way the nation's rural electrification projects can be greatly enhanced (Ileoje, 2004; Sambo, 2006).

In Nigeria rivers, waterfall and streams with high potentials for Small Hydro Power (SHP) development is abundant, harnessing of these hydro resources leads to diversification and use of local natural potentials thereby making sustainable energy supply a reality, which likely be more affordable and an accessible option to provide off- grid energy (electricity). In a recent survey by the Energy Commission of Nigeria on the hydro potentials showed over 278 unexploited SHP sites with total potentials of 734.3 MW were identified in Table 1. In addition to other potentials in Table 2. While Table 3 showed the already existing site that require a to-round maintenance and rehabilitation. However, SHP sites exist in virtually all parts of country with an estimated capacity of 3,500 MW. All the identified sites are attached to river basins were large hectares of land are devoted to irrigation activities as well as rain-

fed agriculture. Thus, these land equally be used for production of food and Biofuel crops for food and energy security.

Table 1: Identified small hydro potential in surveyed states in Nigeria

S/No	State	River Basin	Total Sites	Potential capacity (MW)
1	Sokoto Katsina	Sokoto Rima	22	30.6
2	Niger	Sokoto Rima	11	8.0
3	Kaduna	Niger	30	117.6
4	Kwara	Niger	19	58.2
5	Kano	Niger	12	38.8
6	Borno	Hadeja Jama'are	28	46.2
7	Bauchi	Chad	29	20.8
8	Gongola	Upper-Benue	20	42.6
9	Plateau	Upper-Benue	39	162.7
10	Benue	Lower-Benue	32	110.4
11	Cross River	Lower-Benue	19	69.2
12	Cross River	Cross River	18	28.1

Source: Energy Commission of Nigeria accessed 1/17/2011 http://www.energy.gov.ng/index

Table 2: Identified potential hydro power sites in Nigeria

Location	River	Average Discharge (m)s)	Max. Head	Installed Capacity (pf=0.5) MW
Donko	Niger	1650	17	225
Jebba	Niger	1767	27.10	500
Zungeru II	Kaduna	343	97.60	450
Zungeru I	Kaduna	343	100.60	500
Shiroro	Kaduna	294	95.00	300
Zurubu	Kaduna	55	40	20
Gwaram	Jama'are	75	50	30
Izom	Gurara	55	30	20
Gudi	Mada	41.5	100	40
Kafanchan	Kongum	2.2	100	5
Kurra II	Sanga	5.5	430	25
Kurra I	Sanga	5.0	29	15
Richa II	Daffo	4.0	480	25
Richa I	Moasri	6.5	400	36
Miatakuku	Kurra	2.0	670	20
Kombo	Gongola	128	37	35
Kiri	Gongola	154	30.50	40
Kramti	Kam	80	100	115
Beli	Taraba	266	79.2	240
Garin Dali	Taraba	223	36.60	135
Sarkin	Suntai	20	180	46
Danko	Donga	45	200	130
Gambu	Katsina Ala	170	45	30
Kasimblia	Katsina Ala	740	49	260
Katsina Ala	Benue	3185	25.90	600
Makurdi	Niger	6253	31.40	1950
Lokoja	Niger	6635	15.25	750
Onitsha	Ossa	80	50	30
Ifon	Ossa	759	47	400
Ikom	Cross	1621	15.5	180
Afrikpo	Cross	1704	10	180

Source: Energy Commission of Nigeria accessed 1/17/2011 http://www.energy.gov.ng/index

Table 3: Existing small hydro schemes in Nigeria

S/No	RIVER	State	Installed Capacity (MW)
1	Bagel (I)	Plateau	1.0
	(II)		2.0
2	Kurra	Plateau	8.0
3	Lere (I)	Plateau	4.0
	(II)		4.0
4	* Bakalori	Sokoto	3.0
5	* Tiga	Kano	6.0
6	* Oyan	Ogun	9.0
7	Ikere	Oyo	6.0

*Needs rehabilitation

Source: Energy Commission of Nigeria accessed 1/17/2011 http://www.energy.gov.ng/index

From the three Tables presented the potentials of Nigeria could be clearly observed for the necessary machines to be put in place for the actualization of utilization of the hydro component of the renewable energy into full capacity usage either by the private or government sectors.

Energy Resources

It is universally accepted that fossil fuels are finite and it is only a matter of time before their reserve become exhausted. Therefore, the need for supplementation or alternative that ideally will be non depletable energy source haven identified and recognized. These non depletable sources are replenish able, are also referred to as renewable energy sources as there are available in cyclic or periodic basis (Sambo, 2005; Wolde, 2005). The location of Nigeria globally has favoured the country with various energy systems; fossils and renewable such as wind, solar, geothermal, water, biomass, in addition to conducive climates to producing biofuels of first and second generation (ECN, 2010). However, in Nigeria none of these energy systems had been adequately developed to achieve sustainable development and full capacity utilization to satisfy domestic or international demand (Sambo, 2010; Anon, 2015).

Biofuels

Biofuel are derived directly from living matter. They are essentially, biodegradable and non-toxic. They are manufactured from plants and plant derived materials that contribute to its formation (FAO, 2008). They can be distinguished as a gaseous, liquid or solid fuel and is generally used for vehicles, homes, and cooking. Biofuels are liquid transportation fuels made from plants and animal residues used for car, trucks, airplanes and trains (Schnepf, 2007). The two primary sources of biofuels are ethanol and biodiesel. Ethanol known as ethyl is an alcohol produced from renewable feedstocks such as cassava, maize, sorghum, and potatoes. Biodiesel is a non-toxic, biodegradable fuel made from vegetable oils or animal fats. Specific sources of biodiesel are coconut oils, jatropha, soybean oils, cotton seed oils, and beniseed oils. The use of biofuel reduces air toxic gas emissions radically and greenhouse gas build-up. In terms of biodiesel hybridization, its addition to petroleum produces leads to complete combustion thus reducing dangerous emissions along with their impact on the environment. Modern technology can convert the population into renewable biofuel.

Household, forestry, industry and agricultural wastes are used to produce bioenergy that can be stored for an indefinite time period. This is one aspect of biofuel that differentiates it from other fossil fuels and crude oil. Another feature of biofuel is the fact that it is renewable unlike other natural energy resources such as coal, nuclear fuels and petroleum (Anon, 2010). There are two main sources of biofuel generations, the first generation produced from food crops such as sugarcane, corn, beets, and biodiesel derived from oil crops or seeds, such as rapeseed, sunflower, palm, jatropha etc were regarded as a highly promising source of renewable energy. But hopes faded as researchers found these first-generation biofuels caused environmental problems, and diverted a land and water away from food production, limiting local supplies and driving up prices (Anon, 2011). Now, concerns over the sustainability of using food supplies to produce biofuels has shifted the focus to second generation biofuels in a bid to increase energy output from a broader range of plant sources. Second generation biofuels are based on agricultural residues and invasive plant species, as well as high-yielding non-food crops that can be grown on more marginal or degraded land (Anon, 2011). While research and development are currently dominated by industrialized countries, with commercial production due to start in the next few years, there is considerable scope for developing countries to play a role, provided they can meet certain challenges. A study issued by the (IEA) predicts that biofuels will provide 26% of total transportation fuel in 2050, with second-generation biofuels accounting for 90%. Nigeria, a country well endowed with broad suitable climatic, relief and biological ecology that support the production of these materials, when carefully planned, can be in the front line of world production of biofuels. The vast irrigation lands surrounding the various irrigation projects could serve this purpose adequately producing energy crops both the first and second generation plant materials as well as the irrigated food crops in the same vain. Adeniji (2004) reported in national surveys on irrigation projects posited that irrigation projects in Nigeria are under utilized in terms of water and land intensity. Given the necessary attention food and energy crops could be established hand in hand to secure the nation in energy and food sufficiency. However, at this moment, the environmental and food security costs of biofuels far outweigh their potential benefits. According to the International Energy Agency, biofuels from maize requires high energy inputs and results in small (15%) carbon emission reductions, in comparison with traditional fuel. In contrast, sugarcane biofuels are more energy efficient and save up to 90 percent of carbon emissions. Moreover, biofuels made from grain feedstock are both water and fertilizer intensive, which can damage soil fertility, posing additional threats to food production and food security (Shenggen, 2011). Therefore, research and development efforts in Nigeria should focus on second generation biofuels made from cellulose, hemicelluloses or lignin. Such policies will help lower the grain demand for biofuels and therefore curb the growing food-fuel competition. This would relieve some pressures that are pushing maize, wheat prices up. In the meantime, the expansion of biofuels production should be monitored carefully in order to ensure that it does not divert farmers from producing food crops and that it does not lead to higher food prices. The climatic and agronomic characteristics of the biofuel crops are well adapted to Nigeria condition for growth and sustenance. So, what remains is the policy articulation of the sectors concern and extension on the benefit of cultivation of the biofuel crops. Farmers in Nigeria with adequate extension and proper marketing channels can explore the benefit derivable from the cultivation of the biofuels.

Biofuel Production in Nigeria

Nigeria is well endowed with suitable climate for production of biofuel crops that are adapted to the different geographical regions in commercial basis. Both the first and the second generation of the biofuels could be produced. Production and utilization of biofuel crops can potentially help solve the economic, social and environmental problems, if appropriate policies and related institutional and technological innovations are promoted, Nigeria would be a major exporter of the biofuel crops and the refined bioethanol/biodiesel. Some the biofuels crop adapted to geographical regions are shown in Table 4.

Table 4: First and second generation crop in Nigeria

Crop	Botanical name	Region of adaptation	Installed Capacity (MW)
Castor	*Ricinus communis L*	Middle belt	2.0
Coconut	*Cocos nueifera L*	South East	8.0
Groundnut	*Arachis hypogea L*	Northern	4.0
Niger seed	*Guizotia abyssinica*	North central	3.0
Oil palm	*Elaeis guineensis* J	South south	6.0
Sesame	*Sesamum indicum*	North west	9.0
Soya bean glycine max	*Butyrospermum paradoxum*	North central	6.0

Source: Field survey 2014

Future of Renewable Energy

There are great opportunities for the use of the renewable energy. Technologies in application where electricity, thermal energy or mechanical power is required. Such applications, include thermal power plants, non-thermal electricity generation, Grid power supply, Stand-alone power systems; industrial and domestic cooking and heating of liquids and gasses; drying and processing of agricultural products; water purification, irrigation and potable Water Supply, lighting, etc. However, in view of certain characteristics of the energy sector in Nigeria and the attributes of renewable energy, in comparison to non-Renewable and conventional energy, greater prospects for the use of RE exist in the rural Sector of the economy.

Challenges of Renewable Energy Utilization at Stake

Despite, the availability of potentials to harness the energy, water, and food production for security of the country. Yet diversification into the various energy systems and renewable energy for economic and social development for efficient utilization is lacking. Urgent steps are needed to realize the massive potentials of RE in Nigeria, as part of efforts to achieve energy and food security development goals. Key barriers to Renewable Energy utilization in Nigeria as identified by Akinbami (2001); Anon (2002); Sambo (2006) and Sunday (2012) includes:

Capacity Limitation

The technical expertise to develop and manage renewable energy is adequate and worst still, not realized in the country is often sourced from outside.

1) Infrastructure for manufacturing of renewable energy components is not available in the country. Supply of systems and components is thus dependent on imports.
2) Financial and Fiscal incentives - Financial and fiscal incentives are not available to fast track the development of supply and demand side of the RE energy market.
3) Low Level of Public Awareness – public awareness of renewable energy sources and technologies in Nigeria and their benefits, both economically and environmentally are generally low. Consequently, the public is not well-equipped to influence the government to begin to take more decisive initiatives in enhancing the development, application, dissemination and diffusion of renewable energy resources and technologies in the national energy market.
4) Inadequate resource assessment-reliable database to assist investment decision for RE electricity is absent.
5) Intermittency of Resource Availability – All renewable resources for electricity generation are availability intermittently and cyclic. The challenge of energy storage and system management during periods of lack resources add to the complexity of the system.
6) Zero Resource Cost- A part from of the bioelectricity resource for RE electricity is free, even though this is an advantage ~~for~~ of reducing the operating cost of the RE electricity system. The challenge is to make RE electricity systems operational.
7) High Initial Cost- RE electricity systems have initial cost. This limited the penetration of the system into the market.
8) Deregulated and Liberated energy industry-With the deregulation and the liberation of the energy sector in Nigeria, a conducive atmosphere is created for appropriate tariffs on the electricity services in the country. This opportunity would enable RE electricity to be competitive in the market in the medium to long term.
9) The General absence of comprehensive national energy policy–Nigeria has never formulated a comprehensive energy policy; only sub-sectoral policies were formulated. Since such a policy is pivotal to using energy efficient and renewable energy technologies (RETs), this has to large extent contributed to the lack of attention for the RETs.

Policy Interventions

Energy and water are two main critical resources essential for the social, economic and productivity of any nation. Thus, require an apt policy formulation intervention. Nigeria as a nation needs to implement its energy plan of action in toto for the wellbeing and security of its citizenry. In order for the energy sector to operate efficiently and play its role in the socio-economic development by considering the following as a basic implementation yardstick to surmount obstacles that may hinder the country tapping its natural resource to achieve energy and food security:

(i) Clarify the roles and functions of the various institutions involved in the energy sector increasing the role of the private sector
(ii) Create a transparent legal and regulatory framework for the sector

(iii) Build capacity at the national and local levels for better formation and implementation of energy policies and programmes
(iv) Build capacity of regulatory agencies to provide even-handed and predictable regulation
(v) Develop initiatives to retain local human resource for the energy sector regulation
(vi) Involve all stakeholders in the formation of new policies in the energy sector
(vii) Coordination and information sharing among various projects, government institutional and private sector
(viii) Audit information on energy supply and demand as well as the country resource potentials
(ix) Install appropriate mechanisms to enable modern and efficient energy services to be accessed by the rural population
(x) Enlightenment on production of first and second generation biofuels

Implication

Nigeria currently is paying much attention in the fossil energy sectors. Various contracts had been awarded on the development of gas and other fossil sources, at the expense of the renewable energy sector which have more potentials and diversifiable. The potentials of the renewable sector hold the future. The current trends of research and development in the renewable energy sector are rapid and developing for commercialization. If Nigeria could refocus its agenda to the renewable sector as well, this could make the country to be matched with the current challenges of the energy and food sector globally. This will definitely cater for the future generation of Nigerians to come to benefit from the suitable management of energy and water resources of the country. In the same vein, there is growing emphasis in integrated water resources management to balance the demand for agricultural water, other sector uses, and limit the depletion of ground water aquifers. When combined with effective energy management programs significant opportunities exist to maximize efficiency gains in the water and energy sectors. Thereby reduce waste, trim costs, enhanced overall services to the teeming population.

CONCLUSION

Nigeria is abundantly endowed with water and energy resource potentials. The grossly under-utilized Renewable Energy resources, in terms of its potentials, capacity, and development reveals an abundance of resources that can be harnessed to make Nigeria one of the most industrialized countries in the world. Integrated management and diversification of the duo resources would rightly place the country among the front liners of the energy sector of the world and significantly increases its tradable balance of payment. In addition, energy production through the renewable system is safe and environmentally friendly.

Adequate legislature should be made by government to prevent environmental pollution by Renewable energy industry. The law should promote clean production process, with minimal pollution. Again, adequate laws should be made that would spell out companies – community relations. In order to prevent the occurrence of environmental degradations, and militancy activities typical of the Niger Delta region.

Renewable energy industries should be told at inception, their corporate social responsibilities to host communities. These social responsibilities should be spelt out through

a tri-partied agreement between government, renewable energy companies and representatives from host communities where the resources are available for harnessing.

Tax holidays should be given to the pioneers in the renewable energy industry. Investors' interest and dividends should not be taxed for a period of ten years. Levies paid to government departments and agencies should be eliminated for the same number of years. This to allow the pioneer investors opportunities to acclimatize economically and discharge their obligation procedurally when due.

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