Renewable Energy for Self Reliance: Cornerstone for Sustainable Development of Nigerian Economy

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Abstract

It is a well known fact that access to improved energy services in Nigeria especially in rural areas has not registered significant growth despite the concerted effort towards this trend. Provision of modern energy services to this large population is expected to greatly assist in reversing the high poverty levels found in rural areas. Renewable energy can affect economic growth positively in the areas of household energy, agriculture, small and micro rural enterprises. This can only be possible if the design, development and adoption of such systems is directed towards the attainment of their needs by improving traditional technology, adopting new technology to suit local needs and identifying effective methods for introducing innovation backed-up by dedicated policy documents on renewable and rural energy needs. Government policies are important factor in terms of their abilities to create an enabling environment for the successful implementation of rural energy initiatives. This if carefully planned and executed will enhance impending energy transitions in Nigeria and no doubt serves as the cornerstone for sustainable economy.

Introduction

It is obvious that energy is very significant for human development. Hence it is viewed at a fundamental level as a basis for all existence. Its importance in our daily lives derive simply from the fact that it provides essential human services such as in lighting, cooking, space heating and cooling, water pumping, agriculture and other social services. Although energy services has been in existence from the traditional society where services have been obtained by devices and systems energised only by the muscle power of humans or drought animals which have depended on the biological conversion and stored food into useful energy to pull carts, grind flour, plough fields or draw water. Currently however, in both industrialised and developing countries, there is a variety of fuels to operate more complex systems of energy conversion for cooking, lighting, space heating and cooling, motive

power. Hence, the history of civilization is barely a story of man's progress in harnessing energy and converting it into useful forms. Despite the advances made so far, it has been recognized (Chendo, 2006) that about a third of humanity relies entirely on traditional fuels and technologies for most of their energy services.

It is also a truism that in developing countries people living in rural areas typically use very low levels of biomass (fuel wood, agro-waste, and dung) gathered each day mostly by women and children who spend long hours and considerable human energy in the effort. Thus, lack of access to modern energy has serious adverse implications for the welfare of the vast numbers of urban and rural poor resulting in ill-health, malnutrition, environmental degradation and worsening conditions of poverty and gender inequality. The high level of agricultural and industrial productivity envisaged at present and in the next decade can only be attained if Nigeria is in a position to harness energy many times equal to the muscular capabilities of her population. This can be achieved if Nigeria develops her energy resources before she can finally provide her teaming population with the "better life syndrome" (Chendo, 2006). UNDP (2001) identified five crucial components namely economic efficiency; equity (particularly for women, poor and rural dwellers); empowerment or self reliance; environmental soundness and peace as measures of sustainable development. It is therefore envisaged that the efficient production and use of energy could provide important means to intervene positively in these vital areas of human concern since at the heart of the notion of sustainable development is the ethical imperative that the stock of environmental capital must be preserved for future generation.

Energy and the Economy

In Nigeria electricity supply has been erratic for the past three decades. Nigeria, the sixth largest exporter of crude oil in the world, according to the Vienna-based Organisation of Petroleum Exporting Countries (OPEC) still depends on imported refined products. Nigeria's four refineries with combined capacity of 445,000 barrels per day operate below capacity due to ageing machinery. The situation at present is even more deplorable. It has been reported (Olori, 2006) that according to the Department of Petroleum Resources, the government arm of the oil industry that Nigeria's consumes 30 million litres of refined petroleum per day, while its four refineries jointly produce about 18 million litres per day, leaving a shortfall of 12 million litres to be imported. Also, according to Manufacturers Association of Nigeria (MAN) survey report more than 60 percent of factories in Nigeria depend on generators as their main sources of power supply. This, apart from the adverse effect on the environment increases the cost of manufactured goods which is passed on to the consumers. This in

addition has a negative effect on the competitiveness of local products. In fact, it has been reported by the Bureau for Public Enterprises (BPE), set up by government to sell off loss-making public assets, that economic losses arising from erratic power supply is about one billion dollars annually. Only less than 36 percent of Nigerians have access to electricity (Olori, 2006). This situation, if left unchecked could lead to collapse of the country's manufacturing sector. In this regard, MAN plans to establish an independent power plant to supply electricity to industries. The independent power plant according to Borodo, the MAN president (Olori, 2006) will use abundant gas in Nigeria to power turbines and generate electricity.

It is understatements to say that majority of the inhabitants of Nigeria are poor. This populace reside mostly in the rural area where there are no notable reliable power supply to sustain economic activities. UNDP (2000) report noted that the bulk of rural inhabitants are poor and with irregular income flows. The high level of poverty in rural Africa ranges from 50 percent to 77 percent when the national poverty reference is use. The high level of poverty is reflected in the consumption pattern of modern energy. The provision of modern energy services is expected to greatly assist in reversing the high poverty levels found in rural areas. The bulk of the energy consumed in the rural areas is used in households. Households require energy mainly for cooking, lighting and space heating with cooking accounting for between 90 percent and 100 percent. Firewood remains the most common fuel for cooking in rural areas. The predominance of firewood as the dominant source of cooking energy despite its inefficiency and harmful impact on human health could be attributed to its availability as a 'free' source of energy. In most cases, firewood is collected and not purchased. Kerosene is the most widely used energy source for lighting in rural areas. For high-income rural households, electricity (either from the grid or generator sets) is an option.

Agricultural sector accounts for substantial proportions of the mainstay of the rural populace. In spite of the abundant energy resources, available estimates of Africa's energy consumption indicate limited use of modern energy resources in the agricultural sector. The energy needs for agricultural production in rural areas range from intensive power use in transport, water lifting and pumping, land preparation, primary and seedbed cultivation, weed control, planting, transplanting and harvesting. Limited use of mechanized agricultural practices in Africa means that human labour continues to be an important source of power for agricultural activities in the continent (FAO/ADB, 1995). Human power has limited output when compared to mechanised power sources. A number of renewable energy technologies have demonstrated an encouraging level of success in meeting the demand for energy for

agriculture in rural Africa and therefore holds promise for agricultural advancement for sustainable development of Nigeria's economy.

Renewable Energy can be used in small and micro rural enterprises for economic empowerment of the rural populace. Most of these enterprises are based in the informal sector, and can be categorised into commercial/service enterprises and production enterprises. Commercial/service enterprises include small shops, rural guess houses, beer halls and battery recharging centres. Production enterprises are largely agro-based or forest based activities, and includes saw milling and pottery making.

Policy support issues

The success of any major national/regional level energy initiative is to a large extent, dependent on the existing government policy. Government policies are important factor in terms of their ability to create an enabling environment for the successful implementation of rural energy initiatives for rural areas. The existing policy on Renewable energy developments are general in nature and are contained in the National Energy Policy. Iloeje (2004:37) summarized the Policy thus:

- aggressively and effectively develop and harness solar, wind, hydropower and non fuel wood biomass energy sources and integrate them into national energy mix;
- take particular measure to ensure the use of these energy resources in rural energy supply;
- de-emphasise the use of fuel wood and promote alternative energy resources to fuel wood;
- intensify efforts to increase the percentage of land mass covered by forests; and
- keep abreast of worldwide developments in renewable energy technologies.

There is the need to articulate policy that must address the identified barriers to Renewable energy from making progressive inroad into rural areas. This barrier include low level of awareness, insufficient manpower, high initial cost, little or no domestic manufacturers, high import duties on imported components, subsidies in the conventional that make Renewable energy sources not competitive and limited demand. This is very important since Renewable energies are most appropriate energy technologies for rural areas in the absence of grid rural electrification. Moreover, most rural energy initiatives are often renewable based. There is therefore the need for a clear-cut policy on development and promotion of Renewable Energy Technologies (RETs) to be undertaken within the Energy Sector as Cornerstone for sustainable development of Nigeria economy. In addition, independent rural energy agencies and dedicated rural energy institutions are to be encouraged to pay

attention to rural energy technologies. Furthermore, renewable energy in rural areas has to be backed-up by budgetary allocations. Emphasis should be placed on renewable energy which supplies to a large proportion of the population irrespective of the bulk expenditure to rural power supply.

Renewable Energy: Cornerstone for Nigeria Economy.

There is no doubt that Nigeria is blessed with abundant reserves of major fossil fuels and renewable energy sources as indicated in tables I and 2 below.

Table 1: Nigeria Conventional Energy reserve

Resources	Reserves	Reserves in Energy units (billion toe)	% Total Conventional Energy
Crude oil	23 billion barrels	3.128	21.0
Natural gas	4293 billion m^3	3.679	24.8
Coal & lignite	2.7 billion tones	1.882	12.7
Tar sands	31 billion barrels of oil equivalent	4.216	28.4
Hydro power	10,000 MV	1,954 (100years)	13.1
Nuclear	-	-	-
Total	Conventional/commercial energy sources	14.859	100

Source: Adopted from Chendo 2006

Note:

Toe =Tonnes of oil equivalent

I barrel of oil = 0.136 tonne of oil

1000m^3 of natural gas = 0.857 toe

1000kwhr (primary energy) = 0.223 toe

1 Tonne of coal = 0.697toe

Table 2: Nigeria's Non-Conventional Energy Resources

Resource	Reserves	Reserves (billion toe)
Fuel wood	43.3 million tonnes/year	1.645 (over 100years)
Animal wastes & crop residue	144 million tonnes/year	3.024 (over 100years)
Small scale Hydro power	734.2 MV	0.143 (over 100years)
Solar Radiation	1.0KW per meter land area (peak)	-
Wind	2.0-4.0 m/s	-

Source: Adopted from Chendo 2006

Note:

100kwhr (Primary energy) = 0,223 toe

I Tonne of firewood = 0.38 toe

1 Tonne of Agric waste = 0.28 toe

1 Tonne of Dung Cake = 0.21 toe

Over dependence on conventional energy sources for the ever increasing population resulting in ever-growing need for energy will not only be impossible to meet in terms of cost and availability as is currently being experienced nationwide but will lead to increased environmental degradation, faster depletion of her reserves and the associated problems such as non-renewability, environmental pollution and uneven distribution around the country (Chendo, 2006). On the other hand, non conventional energy sources are renewable, economical, abundant, low cost, convenient to use, transportable and socially compatible. Further more, from economic point of view, it offers 'fresh opportunities for rural development by creating employment, new markets and favours the establishment of cottage industries and agro-energy enterprise in addition to clean, safe and healthy environment.

Renewable energy and the road to sustainable economy

It has been observed that the tropical climate makes solar energy the most viable alternative source of Renewable energy in Nigeria. Harnessing the sun's energy to produce power is an imperative for rural areas where the hope of being connected to the national grid is very remote and extremely expensive (Hamzat, 2006). It has been shown that solar energy is less expensive than electricity generated by the new Power Holding Company of Nigeria (PHCN) that replaced the National Electric Power Authority (NEPA), though power supply has gone worse since its establishment. According to Olori (2006) it costs about 150million naira (about 1.2million dollars) to connect each village to the national grid, while the solar energy project costs only about 10million naira (around 83,000 dollars) per village. A similar project launched in 2002 by the Nigerian Government (Olori, 2006), has lit 200 rural communities in Imo, Ondo and Jigawa states as well as Abuja, the nation's capital. Already in Nigeria, solar energy is gradually gaining prominence as it is used for a variety of applications such as:

i. Village electrification, water pumping and irrigation of farms as in Bishop Kodji village. A small fishing and canoe carving island in the Atlantic Ocean off Nigeria's sprawling commercial hub of Lagos, the first village to be electrified under the Lagos state government's pilot solar energy project. Kodji residents now dry fish by solar-powered drier. Solar energy has brought governance closer to the people who now have access to information more than before.

ii. Introduction of solar energy, for example, in Jigawa state a rural area in Northern Nigeria which lack the modern sources needed for improvements in health, education, transportation and commercial development. Outside the major cities and towns, there has been very little electrification in the region and what supply there is. Is often unreliable. With the intension of addressing the unavailability of energy in villages, the state governor and SELF director after due negotiation in 2001 introduced solar–electricity (photovoltaic or PV) to power essential services in villages of Jigawa state. The projects according to Solar Electric Light Fund (2001) has led to:

- Computer technology trade school and a satellite-based broadband internet and communications system to link all local government districts;

- Powerful solar-powered pumps designed to run, maintenance free for eight to ten years or more and are currently supplying the villages with clean, fresh water from deep wells. This has reduced the time the villagers used to spend getting water for family use;

- The village health clinics which now benefits from solar energy has lights that enables the health officers to see patients at night, vaccine refrigerators allow more people to be vaccinated at greater frequency and fans increase the comfort level of staff and patients alike;

- Streetlights which are among the most valued PV systems used by villagers give people bright places to congregate;

- The Solar-powered micro-enterprise buildings are centred in each village and each centre provides electricity to six very small businesses. This has allowed tailors to move up from manual sewing machines to electric and similar improvements in productivity for other types of businesses;

- The home light system which replaced the kerosene lights offers a better light without the inherent fumes and fire danger of the old kerosene lamps. The houses are electrified using a micro credit scheme where the payment for each system accumulates to purchase additional systems for more homes;

- In Agriculture, it is used to irrigate cash crops which enable farmers to produce and sell more to provide greater income for their families. There is also solar-powered oil expellers that save time and labour while earning more income for women.

For sustainability, a great deal of care has been taken to ensure that this project will be technically, financially and organizationally sustained.

iii. Solar Backup Systems for Computer Networks. Another dimension to the use of Renewable energy is as used in ICT. A modern autonomous (modular) power systems are now available to provide the power source with the characteristics that can match the requirements for the tasks performed in a computerised environment (Lawal,2006). The power sources are reliable, continuous, clean and derived from immediate environment such as:

- Solar power or energy generated from irradiation of the sun;
- Wind power;
- Geothermal, tidal wave energy, biogas (less universally available and less familiar sources.

These energy sources are renewable and environmentally friendly. Lawal (2006) noted that this is currently practiced at University of Jos where the academic environment has deployed solar power backup systems in many of its departments like Bursary, Accounts, Computer Centre/Nunet (VSAT), Library and the Central Administration where power requirement is absolutely crucial.

iv. In the area of cooking, the use of kerosene for cooking is presently more common in the urban and suburban cities in addition to the liquefied natural gas whereas the main cooking fuels in the rural areas are wood fuel, agricultural wastes and animal dung. It has been observed that the use of wood fuel and other biomass, kerosene and LNG affects the environment adversely (Sheyin, 2005; Chendo, 2006) by introducing Carbon 2 Oxide and other greenhouse gases in the household environments. The use of wood fuel leads to soil erosion, deforestation, desert encroachment and shortage of wood for other gainful economic use. It is therefore envisaged that solar energy should serve as major source of energy for cooking in Nigeria considering the abundant, inexhaustible, universal and free sunshine. Solar cooking is currently practised in Nigeria (Sheyin, 2005). Notable among them are the 50 families in the Eastern Nigeria using solar cookers provided by the Nigerian Society for the Improvement of the Rural People (NSRP) (SCI, 2002). In fact, it has been reported that some villagers within Kainji Lake area use solar cookers (SCI, 2003). The solar cookers have faster cooking times due to the intense solar radiation levels available in Kainji area as well as being environmental friendly. Despite the advantages of solar cookers, it use is still not significant and the awareness about it, is not widespread.

Energy demand in rural areas

Energy use in rural areas can be subdivided into three categories namely:

- Household energy;
- Energy for agriculture; and
- Energy for small and micro enterprises (SMcE).

Household energy consumption levels and types of energy used depend on a variety of factors such as the availability and costs of energy sources. Table 3 shows that as incomes increase, the use of modern energy becomes more prevalent in rural households. For instance, while low-income rural households rely mainly on biomass fuels for cooking, high-income households use modern fuels such as kerosene and LPG.

Table 3: Rural Energy Use Patterns in sub-Saharan African Countries by End Uses.

End Use	Rural household Income		
	Low	**Medium**	**High**
Cooking	Dung, residues, wood	Dung, residues, wood, kerosene and coal	Wood, kerosene, coal, LPG and biogas
Lighting	Kerosene, candles	Kerosene, candles and batteries	Kerosene, LPG, electricity
Space heating	Dung, residues, wood	Dung, residues, wood, kerosene and coal	Dung, residues, wood, kerosene and coal
Other appliances	None	Grid or genset-based electricity and batteries	Grid or genset-based electricity and batteries

Source: Karekezi and Kithyoma, 2002

The agricultural sector accounts for substantial proportion of the region's GDP over 20 percent in most countries (World Bank, 2000). In spite of the abundant energy resources, available estimates of Africa's energy consumption indicate limited use of modern energy resources in the agricultural sector. Limited use of mechanized agricultural practices in Africa means that human labour continues to be an important source of power for agricultural activities in the continent (FAO/ADB, 1995). Human power has limited output when compared to mechanised power sources. Table 4 shows the human power consumption for various farming activities. Table 5 on the other hand presents Renewable Energy Technology that could be used for selected Agricultural Processes.

Table 4: Human Power Consumption for Various Farming Activities

Activity	**Gross Power Needed**	**KWh consumed (Assume 7 hour working)**
Clearing bush and shrub	400-600	2.8-4.2
Felling trees	600	4.2
Hoeing	300-500	2.1-3.5
Ridging, deep digging	400-1000	2.8-7.0
Planting	200-300	1.4-2.1
Ploughing with animal drought	350-550	2.45-3.85

Source: WEC/FAO, 1999 & National Energy Foundation, 1995

Table 5: Renewable Energy Technologies Applicable to Agriculture

Renewable Energy Technology	**Selected Agricultural Process**
Photovoltaic Technologies	Pumping, Lighting, Cooking, Crop processing
Solar water heaters	Dairy processing and heat energy for poultry
Wind pumps	Irrigation, Crop processing
Biogas plants	Production of fertilizer
Bio-fuel cook stoves	Milk pasteurization, Heat energy for poultry, Crop drying, Crop processing

Source: AFREPREN/FWD, 1999

Renewable Energy can be use in small and micro rural enterprises for economic empowerment of the rural populace. As earlier mentioned, small and micro rural enterprise are categorised into commercial/service enterprises and production enterprises. Commercial/service enterprises include small shops, rural guest houses, beer halls and battery recharging centres. Production enterprises are largely agro-based or forests based activities, and include saw milling and pottery making. Energy demands in these small and micro rural enterprises are summarised and presented in table 6 below.

Table 6: Renewable Energy Technologies (RET) for Small and Micro Rural Enterprises

RET	Production Enterprises	Commercial & Service Enterprises
Solar drying	Processing of tobacco, timber, coffee, tea, wood and fruits	
Solar water heaters	Crop processing	Clinics, schools
Animal-driven vehicles	Transport	Transport, water pumping
Cook stoves	Beer brewing	Food kiosks, food preparation for clinics, hospitals and schools
Photovoltaic	Diary processing	Electrification of small shops, bars, food kiosks and powering of mobile communication devices
Charcoal kilms	Production of charcoal for sale in rural and urban areas	

Source: Adopted from Best 1992

Conclusion and Recommendations

Electricity, a critical input to certain production processes in small industry and in small-scale commercial activity, is both capital-intensive and expensive to provide by conventional grid extension to rural areas. Electricity costs from decentralized diesel generators are very expensive, a direct consequence of high cost of fuel and great transport distances. Hence, considerable attention has to be given to Renewable Energy Technologies applications in order to address the needs of rural areas. Since rural areas are at a disadvantage in terms of the many of the critical inputs for economic development. Greater participation in the planning and implementation process from governments,

non-governmental organizations and the private sector are needed to relax or deal more effectively with the barriers impeding the diffusion of Renewable Energy Technology in Nigeria economic development. For instance, governments at both national and state levels can take active measures to ensure policy support issues needed to improve the economic competitiveness of renewable energy technologies such as exempting renewable energy equipment from specific taxes and by providing financial incentives in the way of subsidies and low interest loans.

Further more, governments can disseminate information concerning the technical and financial viability of renewable energy and undertake Renewable Energy technologies that may benefit from local technical refinements, adaptations, or from manufacturing techniques that can encourage mass production of component parts. The local private sector can play a prominent role in equipment production, equipment assembly, marketing and sales, maintenance and spare part supply, assembly and service. They can also play active role by working with the private sector in industrialized countries through equipment licensing and joint ventures, establishment of local outlets and investment in projects. The non-governmental organizations can engineer and help to support training and extension, conducting assessments of local needs, educating the public, develop local maintenance capabilities and stimulate the establishment of appropriate local energy companies. Thus, for renewable energy to serve as corner stone for economic development, the barriers that prevent it from competing equally in the marketplace with conventional technologies have to be removed. Greater emphasis has to be placed on the dissemination phase of the diffusion process which calls for a greater involvement from the local private sector and non-governmental organizations. Finally, given Nigerian current technological level, its infrastructure and its resource availability, if fully developed, the non-conventional energy sources can contribute significantly to the national energy mix leading to sustainable development of Nigeria economy.

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