Status of Renewable Energy Policy and Implementation in Nigeria

Temilade Sesan

Institute for Science and Society, Faculty of Social Sciences, Law and Education,

University of Nottingham, United Kingdom.

April 2008

1. Introduction

Energy is an important contributing feature in the development of any country or region. Indeed, energy is fundamental to the fulfilment of basic individual and community needs such as lighting, transportation, provision of water, food, health and education. Since all these services are the indices by which a nation's progress and development are measured, it follows that energy is a major determinant of every country's economic and social development.

Up to date, fossil fuels (coal, oil and natural gas) have been the main source of energy, meeting three-quarters of total world energy needs. However, rising concerns about the security of energy supplies have led to a global search for alternative energy sources. Sustainability is a key factor influencing the long-term viability of any energy resource, and it comes as no surprise that it is at the forefront of the global campaign to abandon the use of fossil fuels.

The drive for sustainable energy is not propelled by concerns over energy security alone. Fossil fuels have been a major cause of adverse environmental and social consequences such as climate change, air pollution and mining accidents. Renewable energy constitutes a panacea of sorts, offering solutions to every one of the problems posed by conventional energy sources. They are clean, safe, inexhaustible, and they satisfy the criteria for sustainability prescribed by the United Nations: the ability to meet the energy needs of the present without compromising the ability of future generations to meet their own needs.

Renewable energy sources, commonly referred to as 'renewables', include solar energy, wind energy, biomass, hydro (water), geothermal energy and tidal energy. Several definitions of renewables have been proffered. Twidell and Weir[1] define renewable energy as 'energy obtained from the continuous or repetitive currents of energy recurring in the natural environment'. Sorenson[2] says that renewables produce 'energy flows which are replenished at the same rate as they are used'. Whatever the definition, the concept remains the same: renewable energy sources, in contrast to fossil fuels, are environmentally friendly, ubiquitous, self-replenishing, infinite, and consequently considered world-wide as the way of the future.

[1] See Boyle, G. (2004)
[2] *Ibid.*

2. Energy in Nigeria

For the purpose of reviewing energy use patterns, the Nigerian economy can be divided into industrial, transport, commercial, agriculture and household sectors.[3] The household sector accounts for the largest share of energy use in the country – about 65 percent. This is largely due to the low level of development in all the other sectors.

The major energy-consuming activities in Nigerian households are cooking, lighting and use of electrical appliances – in that order. Cooking accounts for a staggering 91 percent of household energy consumption, lighting uses up 6 percent and the remaining 3 percent can be attributed to the use of basic electrical appliances such as televisions and pressing irons.[4]

The major household energy carriers are fuel wood, kerosene, electricity and liquefied petroleum gas (LPG). Fuel wood is the most widely used, supplying over 80 percent of household energy, while less than 20 percent is supplied by the other sources and complemented by small quantities of coal and charcoal.

Energy consumption per capita in Nigeria is very small – about one-sixth of the energy consumed in developed countries. This is directly linked to the level of poverty in the country. Gross Domestic Product (GDP) and per capita income are indices that are used to measure the economic well-being of a country and its people. GDP is defined as the total market value of all final goods and services produced within a given country in a given period of time (usually a calendar year). Per capita income refers to how much each individual receives, in monetary terms, of the yearly income that is generated in their country through productive activities.[5] That is what each citizen would receive if the yearly income generated by a country from its productive activities were divided equally among everyone.[6]

With 2002 GDP of about $45 billion and per capita income of only about $290, Nigeria is one of the poorest countries in the world.[7] The National Economic Empowerment and Development Strategy (NEEDS) estimates that about 70 percent of the Nigerian population is currently living in poverty.[8] That percentage translates into about 98 million Nigerians. Incidentally, about that many Nigerians do not have access to energy from the national grid. Over the past few decades, the recognisable trend in the country has been that of deepening poverty with deteriorating energy infrastructure. Incidence of

[3] Oladosu et al (2004)
[4] *Ibid.*
[5] *Ibid.*
[6] *Ibid.*
[7] Energy Commission of Nigeria (2005)
[8] *Ibid.*

poverty increased from 28.1 percent (18.26 million people) in 1980 to 65.6 percent (76.1 million people) in 1996.[9] National electricity generation capacity in 1990 was 5958 megawatts to meet a load of 4000 megawatts.[10] Subsequent increase in capacity was less than proportionate to load growth, hence the start of electricity shortage in the country. As a matter of fact, since the generating system was upgraded in 1990, no new units have been added.[11] Today, less than 3000 megawatts are being generated to meet a demand load of almost 6000 megawatts.

The power sector in Nigeria is so inadequate that it constitutes a major roadblock to economic progress and social well-being.[12] Access to cost-effective and sustainable energy services is critical to re-launching the Nigerian economy and meeting MDG and NEEDS targets.[13] Several tools will be instrumental to achieving a vibrant and secure energy future for the country, one of which is a functional energy policy.

3. The Nigerian Energy Policy

A comprehensive and coherent energy policy is essential in guiding a country towards efficient utilisation of its energy resources. It must be said however that the existence of an energy policy, while crucial, does not guarantee responsible management of a country's energy resources.

The Nigerian National Energy Policy was last reviewed in April 2003. Before 2003, the country had no comprehensive energy policy. It did have separate policy documents for different energy sub-sectors: electricity, oil, gas and solid minerals. Prior to 2003, there was no consideration whatsoever for the inclusion of renewable energy sources in the national energy mix. The 2003 Energy Policy document, for the first time, included elements of renewable energy planning, though in a cursory manner.

The overall thrust of the National Energy Policy (NEP) is the optimal utilisation of the nation's energy resources for sustainable development.[14] The policy identifies renewable energy as one of the sub-sectors of the nation's energy sector, along with oil, natural gas, tar sands, coal and nuclear energy. This is a significant point because it shows that the policy acknowledges the fact that renewable energy is situated within the context of a bigger picture – the energy sector. For a renewable energy plan to be totally effective, it must be steeped in an equally effective national energy policy.

[9] Energy Commission of Nigeria (2005)
[10] Website of the National Electric Power Authority, Eko Zone (2005)
[11] *Ibid.*
[12] *Op. cit*, Ref. 10
[13] *Op. cit*, Ref. 10
[14] Energy Commission of Nigeria (2003)

The National Energy Policy acknowledges that despite the abundant energy resources available in Nigeria, they have not been properly managed to satisfy the nation's energy needs. The Nigerian economy is predominantly oil-driven, but the contribution of oil to GDP is very small indeed. In 2001, oil revenue alone accounted for about 98.7% of exports and 76.5% of total government revenues.[15] Compared with the GDP and per capita income figures quoted earlier, it is evident that the oil sector has had very little real impact on the Nigerian economy.

Government's over-dependence and excessive fixation on oil has slowed down the development of alternative sources of energy, even when the need is glaring. This is more distressing when we realise that the Nigerian government is almost entirely responsible for the ownership and management of energy supply companies. The failure of government to prioritise energy supply is evident in its reluctance to provide adequate funds for development of the sector. This lack of funds, coupled with irresponsible management of available resources has crippled the nation's energy sector. The result of this neglect is inadequate and unreliable supply of electricity and non-electricity energy nationwide. The National Energy Policy implies that government has not allocated sufficient funds to the development of energy because there are other important issues needing attention. This is true, but government has to realise that energy is the fuel that powers all other activities – transport, industry, agriculture, health, education, security.

The all-pervasive nature of energy requires that policies be made that are in sync with other sectors of the economy. By the provision of the Energy Policy, the Energy Commission of Nigeria (ECN) is the government body responsible for the coordination of activities within the energy sector. It is also responsible for overseeing the implementation of the objectives spelt out by the Energy Policy. However, interaction and cooperation between the ECN and other relevant government organisations is very weak. Even within individual organisations, processes and systems are inefficient and poorly coordinated. Furthermore, the very structure of the institutional fabric is weak and inconsistent. Like links in a chain, some hoops are missing and therefore the circle can never be complete. It is very necessary, for instance, to have representations of government energy institutions at the grassroots level, in the form of state and local government departments.

Private sector participation in the Nigerian energy sector is very minimal indeed. The only notable presence of privately owned companies is in the upstream oil and gas sub-sectors. Even at that, their level of involvement is slight when viewed against the backdrop of the national situation. The National Energy Policy recognises this and states

[15] Energy Commission of Nigeria (2003)

that vigorous private sector investment by both foreign and local companies is necessary for effective restructuring of the energy sector.

It is expedient to be aware of the objectives of the National Energy Policy, for it provides the context out of which the nation's renewable energy ambitions have emerged. Realisation of these objectives will provide a veritable platform on which future renewable energy efforts can thrive effortlessly. The following points summarise the objectives stated by the Nigerian National Energy Policy:

1. Optimum development of Nigeria's energy sources
2. Diversification of energy sources
3. Achievement of national energy security
4. Efficient energy supply
5. Guarantee of adequate, reliable and sustainable supply of energy for national development
6. Development of human and institutional capacity
7. Encouragement of greater indigenous participation in the energy sector
8. Promotion of local and foreign investment to boost private sector participation in the energy sector.

4. Renewable Energy in Nigeria

Renewable energy sources have contributed to Nigeria's energy mix for centuries now, albeit in a largely primitive way. Fuel wood - or what is commonly referred to as woody biomass - is the longest standing primary energy source for rural Nigeria, and indeed, for much of the African continent. Large hydropower has also featured substantially as an energy source, providing about 32 percent of Nigeria's national electric grid supply.

Nigeria's adoption of 'new' renewable energy sources – solar photovoltaics, solar thermal, wind, small hydropower and efficient biomass – is relatively recent. The country is endowed with significant, even abundant quantities of each of these resources. Despite this huge potential, the existing renewable energy projects in Nigeria are very few and far between. The few existing projects are mostly funded and implemented by international agencies and non-government organisations, and they are typically on pilot or demonstration basis. The mode of financing is normally through grants, resulting in a distorted market situation that can neither be sustained over time nor replicated throughout the country. These funded projects are usually implemented in the rural areas of the country, where the need is greatest. A handful of wealthy individuals and corporations have installed standalone renewable energy systems to supplement the

erratic power supply from the national grid, but there is no official estimate of the number.

In effect, the level of renewable energy dissemination in Nigeria is very low, almost negligible. The rate of renewable energy uptake in the country is not at par with that of the global renewable industry. It is worth examining the current national state of each renewable energy technology in some detail:

5.10 Solar Photovoltaic

Solar radiation is abundant in Nigeria, but the exact exploitable solar resource base currently available in the country is not known. This is because there is not enough infrastructure and equipment with which to conduct solar radiation measurements. The Nigerian Meteorological Agency operates about thirty measuring stations, most of which are airport weather stations. The data from these stations is used to calculate an estimate of the possible total solar radiation in the country.

Nigeria is far behind developing countries such as the United States, the United Kingdom, Japan and Germany in developing solar photovoltaic technology. Local research and development activity in this technology is scanty, with very little to show for it. The few photovoltaic installations in the country are all imported. In a 1999 survey conducted by the ECN, it was gathered that there were 44 companies and research centres involved in the importation and installation of photovoltaic systems. Only one indigenous company, *Exide Batteries Nigeria Limited*, produces batteries for use in photovoltaic systems. However, even these locally produced batteries do not meet the standards specified for solar photovoltaic systems. Another local company, *Solar Electric Systems*, produces solar photovoltaic refrigerators that have been deployed in a few remote areas.

Because solar photovoltaic technology is mainly imported into Nigeria, acquisition costs are prohibitive. This is the single greatest challenge that needs to be surmounted to achieve widespread dissemination of solar photovoltaics in the country.

5.11 Solar Thermal

Solar thermal appliances generate non-electricity energy from solar radiation. A lot of advancement has been made globally in solar thermal technology. Tested and proven solar thermal applications include solar water heating, solar cooking, solar drying, and solar refrigeration. In Nigeria, considerable research work has been done in this area. In

fact, the National Centre for Energy Research and Development (NCERD) at Nsukka, Nigeria is internationally recognised for the research and development work it has carried out on solar absorption refrigeration.[16]

Solar dryers, solar water heaters, solar cookers and solar chick brooders have been developed in various research laboratories around the country. However many of these locally developed appliances, while functional, have not yet been developed to international standards. Furthermore, most of them are only still at the research and development stages. None of the solar thermal applications is yet commercially viable in Nigeria, despite the fact that most of them are economically competitive with conventional applications. It would seem that the push to drive these technologies from the national laboratories to the market place is simply lacking.

On the other hand, public awareness of the benefits and potential of solar thermal systems is still very limited. As a result there is very little demand for these systems. Also, the failure of decision makers at all levels to recognise solar thermal energy as a valid energy supply option is another problem. These limitations on both the demand and supply sides have for a long time prevented solar thermal technology from reaching its full potential in Nigeria.

5.12 Wind

The Nigerian Meteorological Agency carries out routine measurement and collection of national wind data. However, this information is yet to be translated into wind atlases and wind maps for the country. Nigeria falls into the poor/moderate wind zone. Wind speeds are highest in the coastal areas of the South and in the hilly regions of the North. It follows therefore that these will be the most economically viable sites for wind energy development in Nigeria.

Global wind energy utilisation has over the last decade grown so astronomically that wind technology is currently the most developed (and consequently one of the cheapest) renewable energy sources in the world. In fact, wind energy technology costs are now becoming competitive with even established conventional energy sources. However, wind energy utilisation in Nigeria is practically minimal and relatively insignificant.[17]

The low level of technological development in Nigeria is probably the major cause of high wind energy costs in the country. There is currently no local supplier or manufacturer of

[16] Energy Commission of Nigeria (2005)
[17] *Ibid.*

wind energy systems in Nigeria. None of the energy research centres in Nigeria has an appreciable wind research programme due to inadequate funding. There is therefore lack of capacity and experience in the country on wind power development.[18]

Ironically, wind energy was harnessed for pumping water in Nigeria as early as the 1960's. Hundreds of locally manufactured wind pumps were installed in the northern part of the country, but lack of maintenance has rendered them useless. Two northern states, Jigawa and Kano, have made recent attempts to resuscitate the use of wind energy in the region, but the projects are still largely experimental. In spite of these shortcomings, there is considerable scope for wind energy development in Nigeria, especially for water pumping and photovoltaic or diesel generator hybrid systems for off-grid electricity generation.

5.13 Small Hydropower

Nigeria has an abundant supply of rainfall, dams, rivers and streams distributed all over the country. About 30 percent of the nation's grid-connected electricity is generated from large hydropower stations. This utilisation represents only 14 percent of the country's total exploitable hydro potential, leaving an untapped 86 percent. It is important to note that the declared resource potential is not precise. The exact figures are likely to be much higher, as present figures are based on a survey of 12 states carried out in 1980. Fresh surveys carried out in all 36 states of the Federation will provide up-to-date information on the hydropower resource base.

There are currently only six small hydropower schemes operating in Nigeria: four in Plateau State, one in Sokoto State and one in Kano State. The four schemes in Plateau State were completed between 1923 and 1964 by the Nigerian Electricity Supply Corporation Limited (NESCO). These projects have since supplied uninterrupted power supply to the locality. This is a very encouraging example of how well locally developed technology can thrive if implemented properly. Till date, NESCO is the only indigenous company operating small hydropower schemes in Nigeria. No new schemes have been implemented by NESCO or any other company since 1964.

Small hydropower schemes are particularly advantageous because they can be developed independently of the national grid – a feature which is especially desirable for rural, remote electrification. It's a bit surprising that small hydropower technology, though proven to be locally feasible, still defies large scale implementation in Nigeria. This indicates that there is a deeper root problem that needs to be identified and tackled.

[18] Energy Commission of Nigeria (2005)

5.14 Biomass

Biomass energy or bio-energy refers to energy derived from the conversion of biomass into liquid or gaseous fuel.[19] Biomass is the organic material produced by photosynthesis, a process that converts solar energy into stored chemical energy.[20] Biomass sources generally include wood, charcoal, animal dung, leaves, straw, agricultural residues, sawmill residues and dedicated crops. Biomass fuels are overwhelmingly the most important energy source for rural households, agricultural production and rural industries.[21]

Wood is currently the main source of fuel for over 70 percent of the Nigerian population, particularly rural dwellers. This is because these people cannot afford to pay for commercial cooking fuels such as kerosene and gas. Nigeria is naturally rich in fuel wood, but excessive wood-gathering activity has caused critical depletion of this resource. The implication for the environment is that woodlands run the risk of deforestation, which in turn increases the risk of other hazards such as erosion and flood. Charcoal is also widely used for cooking in slightly larger towns and cities in the country.

Nigeria's annual production of agricultural biomass is enormous. 94 percent and 68 percent of Nigerian households are engaged in crop farming and livestock farming respectively.[22] This means that there exists a huge potential for the successful deployment of biomass energy in Nigeria, particularly in the rural agricultural areas. There are various biomass energy technologies for various end uses: biogas, biofuels, improved woodstoves and biomass briquetting.

Biogas and *biofuel* technologies are used for the conversion of organic biomass matter to gaseous and liquid states respectively. Biogas is mainly used for household heating, cooking and lighting, as well as energy production for agricultural and industrial processes. Biofuels are gradually being used to replace conventional petrol and diesel, to reduce the quantity of carbon dioxide emitted by vehicles on the road.
Biogas research started in Nigeria in 1982. Since then, research activity has been sustained, but not strongly enough to make the technology attain commercial status in the country. So far, less than twenty biogas pilot projects exist in the country.[23]

[19] Karekezi and Ranja (1997)
[20] UNIDO (1994)
[21] Energy Commission of Nigeria (2005)
[22] *Ibid.*
[23] *Ibid.*

Vigorous research efforts have been made globally to develop *improved woodstoves* to replace the traditional three-stone open fires commonly used for cooking in rural areas. Apart from the environmental hazards caused by wood gathering, traditional open fires are very inefficient and the fumes pose severe health hazards to the women and children who typically use them. Using three-stone fires, only 5–10 percent of the wood is converted into heat energy. This means that at least 90 percent of the calorific value of the wood is wasted.

Countries like India, China and Kenya hold world records in the development and use of improved woodstoves. However, in spite of all these international breakthroughs, widespread development and dissemination of improved woodstoves is still not a reality in Nigeria. The fact that the technology is relatively cheap and locally obtainable has proven not to be enough incentive for complete take-off of this technology in the country.

All responsibility for research, training, development and dissemination of improved woodstoves lies solely with the two renewable energy research centres in Enugu and Sokoto states. The research centres have designed and sold some improved woodstoves to a few individuals. Without significant support from government and industry, it is not surprising that research findings hardly ever leave the laboratories. Local craftsmen and potters who have the basic idea of how these stoves work have taken it upon themselves to independently produce and market various versions, the quality of which cannot be assured. Despite the fact that the local craftsmen glaringly present the greatest opportunity for widespread dissemination of woodstoves, there is little collaboration between these craftsmen and the research centres.

Biomass briquetting refers to the process of refining raw biomass material (such as fuel wood, charcoal, crop residues, animal waste) into standard mini-brick units with improved efficiency. Cow dung cakes have been used over decades for heating and cooking in developing countries like India, China and even the northern part of Nigeria. Briquettes are compact, condensed, concentrated, uniform in size, and thus easier to store and transport. Locally produced briquettes typically have up to seven times more energy content than unprocessed biomass. About 70 percent of briquette content is converted to heat energy when used for cooking, compared to only 5-10 percent conversion in traditional biomass sources. Apart from household applications, biomass briquettes can be used in rural industries such as small-scale foundries, kilns and bakeries. Biomass briquetting technology has the potential to drastically reduce the rate of deforestation in developing countries, because it provides a means to get more energy

from less wood. Globally, work is being done to further improve the efficiency of biomass briquetting processes and products.

In Nigeria, several briquette production machines have been developed by the energy research centres. As is the case with improved woodstoves, the research centres shoulder most of the responsibility for development and dissemination of biomass briquetting technology. Design, marketing, training, operation and maintenance of this technology are all handled by the research centres, without a central implementing body to coordinate their activities. There is no system in place for monitoring the degree of briquette demand and supply, or for examining how the end users engage with the technology. There is only one functioning small-scale sawdust briquetting company in Nigeria, located in Ogun State. Another briquetting company in Kaduna State is yet to commence production.

The biomass technologies described above are mainly small scale technologies. There are other, larger scale biomass technologies such as cogeneration, biofuel production, pyrolysis and gasification. With the exception of biofuels, there is currently no indication of the implementation of these large scale technologies in Nigeria.

5. Barriers to Renewable Energy Implementation in Nigeria

In examining the status of each renewable energy technology as has been done in the preceding section, it is very easy to recognise the barriers and challenges facing the growth of renewable energy in Nigeria. Regardless of the specific technology, the barriers to implementation have proved to be the same across board, with very few exceptions. The barriers are explained under the following broad headings:

1. Policy and regulatory
2. Financial and market
3. Technological
4. Institutional
5. Socio-cultural

5.10 Policy and regulatory barrier

Well-formed policies are essential for the successful implementation of any technology in a country. Nigeria currently has no comprehensive Renewable Energy Policy. There is brief mention of renewable energy technologies in the 2003 National Energy Policy, but it is not detailed enough to give proper guidance for implementing a national renewable energy programme. The Energy Commission of Nigeria in November 2005 drafted a

National Renewable Energy Master Plan (REMP), in line with the goals laid down by the National Energy Policy, the National Policy on Integrated Rural Development, the Millennium Development Goals (MDGs) and the National Economic Empowerment and Development Strategy (NEEDS).

The overall objective of the REMP is to articulate a national vision, targets and a road map for addressing key development challenges facing Nigeria through the accelerated and exploitation of renewable energy.[24] It classifies renewable energy targets into three levels according to the time frame for implementation: Short term (2005-2007); Medium term (2008-2015); and Long term (2016-2025). Therefore the whole plan spans across a period of 20 years, by which time new renewable energy sources are expected to be contributing 10 percent of the nation's energy supply.

The REMP comprises six different activities to be implemented within six different programmes:

- Framework Programme for Renewable Energy Promotion
- Nigerian Solar Programme
- Nigerian Small Hydro Programme
- Nigerian Wind Programme
- Nigerian Biomass Programme
- New Energy Research and Development Programme

One shortcoming of the REMP is that it does not advocate a separate rural renewable energy programme. It does acknowledge that renewable energy is a viable tool for fostering rural empowerment and development, but it does not fully capitalise on the unique opportunity presented for rural development by renewable energy technologies.

The REMP is useful at the present stage of renewable energy in Nigeria, but it should not be viewed as a substitute for a National Renewable Energy Policy. Indeed, the REMP makes provision for the review of policy and regulatory instruments within the Framework Programme for Renewable Energy Promotion. The Framework Programme is in fact designed to address every one of the barriers to implementation that have been identified above. This means that any piece of research done to eliminate any of the barriers will contribute to strengthening the Framework Programme laid out by the REMP. This is extremely significant, as the Framework Programme provides the general context within which each of the other specific programmes will work smoothly.

[24] Energy Commission of Nigeria (2005)

The objectives of the REMP are laudable, but government is already falling behind on its plans. The deadline for reaching the short term goals (2007) is past, and not many of the set tasks have been accomplished as yet. The projected electricity supply from all sources (conventional and renewable) by 2007 was 7000 megawatts, with 56 megawatts to be supplied by renewable energy sources. Today actual figures are much lower. Total electricity generation in the country is just above 2000 megawatts. The proportion of the total generated by renewables is not officially known, but it is very negligible.

5.11 Financial and market barrier

According to an opinion survey of renewable energy experts, financing is the main barrier for rural renewable energy projects.[25] Renewable energy technologies typically have higher initial costs than conventional sources of energy. However, renewable energy systems have long life spans and low maintenance costs, leading to much lower life cycle costs than conventional systems. The problem with this is that people do not care much about life cycle costs; they are more concerned with how much the technology costs up front. Many consumers prefer to keep the initial cost low rather than minimise the operating costs which run over a longer period of time.[26] This kind of first cost bias is particularly evident in rural Nigeria where the consumers are low income earners who do not have access to favourable credit.

Widespread implementation of renewable energy in Nigeria requires significant, even heavy financial investment by both the public and private sectors. Implementation of the REMP is estimated to cost $34 million, $1.5 billion and $5 billion in the short, medium and long term respectively. Achievement of these targets will require the participation of stakeholders at all levels.

Historically, the energy sector in Nigeria has been managed by the public sector. Only in recent years - from 2001 till date - has the government put up units of the national power company for privatisation. This is a positive step forward, as active involvement of the private sector is needed for competitive generation of power from renewable energy sources. However the privatisation process is still underway, and so the effects have not begun to be felt in the power sector.

Banks and other financial institutions also have a part to play in the energy revolution. Innovative and affordable financing plans must be readily available to individuals for the procurement of renewable energy systems.

[25] Monroy, C. R.; Hernandez, A. S. (2007)
[26] Reddy et al. (2004)

The need for private sector participation in national renewable energy implementation cannot be overemphasized. It is only then that a sustainable, realistic renewable energy market will be created, as opposed to the distorted market that is so often created by purely government and international aid-driven programmes.

5.12 Technological barrier

This encompasses a whole range of issues, including insufficient resource data; substandard product quality; inadequate research and development activity; limited human and manufacturing capacities.

As discussed earlier, there are currently no accurate records of solar, wind, hydro and biomass resource availability in Nigeria. The few data collection stations that exist are furnished with obsolete measuring equipment which are several decades old.

Also, the manufacturing industry in Nigeria is not well developed. Majority of the finished goods and services consumed by the people are imported from Europe and Asia. Engineers are not well trained in renewable energy technology and thus are not conversant with the best applications and limitations of different technologies.

Lack of local skilled labour to operate and maintain renewable energy equipment is another major deterrent to their widespread adoption, especially in rural Nigeria. Particularly in remote areas with restricted access, on-hands maintenance is needed since frequent visits by repair and maintenance staff is difficult. Failure to provide regular maintenance of the equipment when it is required leads to their complete breakdown, thereby defeating the purpose of the initial investment. A good example of this are the wind pumps installed in northern Nigeria in the 1960's, which are all non-functional now due to inadequate maintenance.

Furthermore there is a general lack of knowledge among the people about acceptable quality and standards of technology. This means that users and installers alike are not likely to be able to distinguish between good and bad equipment and make informed choices,[27] translating into potentially high occurrences of sub-standard installations.

Renewable energy education has not been incorporated into the academic curriculum of universities and other tertiary institutions in Nigeria. There is presently no educational institution in the country offering instruction in renewable energy at any level. The application of renewable energy to fields such as engineering, geography and architecture is not being taught, and as such these professionals are not aware of the value that renewable energy can add to their work.

[27] Wilkins (2002)

Research and development into locally suitable renewable energy technologies by government-commissioned institutions so far has not been sufficient to engender widespread dissemination of solutions to the specific energy needs of people. The two main centres for energy research are affiliated to the Energy Commission of Nigeria. They are: the National Centre for Energy Research & Development (NCERD), Nsukka and the Sokoto Energy Research Centre (SERC). These establishments are responsible for manpower development, dissemination and promotion of renewable and alternative energy technologies in Nigeria.[28] A handful of other agencies have renewable energy components integrated into their programmes,[29] thus complementing the efforts of main research centres. Some remarkable results have been recorded in these centres, especially in solar thermal and biogas technologies. However, a lot of work still needs to be done in creating a sustainable framework for transferring energy solutions from the laboratories to the market place.

More effort needs to be put into the development of indigenous renewable energy technology in Nigeria. It is not in the best interest of the people to wholly rely on renewable energy systems imported from foreign countries. Apart from the inevitably high expense incurred, imported technology many times is not appropriate to the needs of the local population. Furthermore, it is important to realise that building local technological capacity is one of the surest ways to make renewable energy technology affordable to the majority of Nigerians.

5.13 Institutional barrier

Nigeria lacks strong institutional leadership for renewable energy.[30] A redesign of the institutional framework leading to an actor, or set of actors that will champion the development of renewable energy is required.[31]

An efficient institutional framework is the element that will provide direction and coordination for all renewable energy activities in Nigeria. It is essential that adequate institutional infrastructure exists to serve as the implementing instrument of all social and technological innovation in renewables. As shown in the earlier discourse on solar thermal and biomass technologies in Nigeria, the inability of research centres to commercialise developed products is partly due to inadequate institutional support from administrative and implementing agencies.

[28] Ikuponisi (undated)
[29] *Ibid.*
[30] Energy Commission of Nigeria (2005)
[31] Energy Commission of Nigeria (2005)

The primary government body for the development and implementation of renewable energy in the country is the Energy Commission of Nigeria (ECN) established in 1979. Part of the mandate of the ECN is to:

- Develop, promote and harness the country's renewable energy resources and incorporate all viable ones into the national energy mix;
- Promote decentralised energy supply, especially in rural areas, based on renewable energy resources;
- De-emphasize and discourage the use of wood as fuel;
- Promote efficient methods in the use of biomass energy resources;
- Keep abreast of international developments in renewable energy technologies and applications.

As laudable as these aims are, it is unfortunate to note that only a very small degree of achievement has been realised. It is expedient to conduct research to understand and consequently address the reasons for this shortfall. Implementing institutions such as the ECN are crucial and strategic to the success of such a nascent intervention as renewable energy technologies in Nigeria. Their performance can make all the difference between the success and failure of well laid-out plans.

The Nigerian Renewable Energy Master Plan calls for the establishment of a National Renewable Energy Agency, pending when a full Ministry of Renewable Energy can be set up. The agency is expected to encourage efficiency in the provision and use of all types of energy; raise the quality of management and training in energy provision and use; heighten public awareness of energy-related issues; encourage local institutional reforms to help meet policy goals; and reduce environmental risks.[32] This is a worthy initiative, but much more important than the setting up of agencies is the need to understand how they work; why, if at all, they need to be established; patterns and trends that indicate probability of success or failure; what needs to be done to make them function even more effectively, and their interactions with other relevant institutions at various levels.

5.14 Socio-cultural barrier

This has to do with the awareness, perception and attitudes of people to new renewable energy technologies. To the majority of Nigerians, renewable energy technology in all its forms is completely novel. There is a general lack of awareness about what options are available and what benefits can be obtained from each of these options. This is a

[32] *Op. cit,* Ref. 32

foundational issue, as there is no way renewable energy systems can be optimally operational in the country if the prospective end users are ignorant of their potential.

This situation is the result of a number of factors. For one, about 70 percent of Nigerians - most of who live in rural areas - do not have access to proper means of information dissemination. In fact, some rural communities in Nigeria still rely on the services of town criers to pass across important information. Mostly, information dissemination is accomplished by hearsay. The result is that a lot of people find it difficult to obtain relevant information on renewable energy technologies, and so are quite content to continue in their well-known traditional methods.

For some people, the hurdle of awareness has been crossed and they actually have an idea of the concept of renewable systems. In a few communities, pilot projects exist as testimonies to the effectiveness of these systems. However, widespread acceptance of the technology is yet to be achieved. Decisions to adopt renewable energy technologies are generally influenced by consumer perceptions of their quality and usefulness when compared to conventional technologies.[33] Renewable energy technologies are generally perceived to be used with discomfort or sacrifice rather than as providing equivalent services with less energy and cost.[34]

Moreover, the local culture, religion, superstitions, practices and beliefs of various communities are bound to influence their view of the net benefits to be derived from any new technology introduced to them. For instance, Nigeria operates a cash economy in which the people rely much less on credit than those in developed countries. It will therefore require some effort to persuade a rural farmer who has mastered the art of living strictly within his means to adopt a technology that is outside of his budget and thus may require him to take out a loan.

Research Questions

[33] Reddy, et al. (2004)
[34] *Ibid.*

Bibliography

Boyle, G. (ed) (2004). *Renewable energy: Power for a sustainable future*, 2nd edition, London: Oxford.

Energy Commission of Nigeria (2003), *National Energy Policy.*

Energy Commission of Nigeria (2005), *Renewable Energy Master Plan.*

Energy Commission of Nigeria (2006), *National Energy Master Plan,* Federal Ministry of Science and Technology.

Ikuponisi, F. (undated). *Status of renewable energy in Nigeria,* Energetic Solutions Conference.

Karekezi and Ranja (1997) *Renewable Energy Technologies in Africa*, Zed Books Limited with African Energy Policy Research Network (AFREPREN) and Stockholm Environment Institute (SEI).

Monroy, C. R., Hernandez, A. S. (2007) *Strengthening financial innovation in energy supply projects for rural exploitations in developing countries,* Renewable and Sustainable Energy Reviews, doi:10.1016/ (Article in Press)

Oladosu et al. (1994) *Nigeria's household energy sector: Issues and supply/demand frontiers.* Energy Policy, 22 (6), 538-49.

Reddy et al. (2004) *Diffusion of renewable energy technologies – barriers and stakeholders' perspectives,* Renewable Energy, 29 (9), 1431-47

Sorenson, B. (1979) *Renewable Energy,* London: Academic Press

Twidell et al. (1986) *Renewable Energy Resources*, London: Spon.

UNIDO (1994) *Biomass Energy for Industrial Development in Africa: Preparatory Assistance,* Project Document No. US/REF/94/080.

Wilkins, G. (2002) *Technology Transfer for Renewable Energy: Overcoming Barriers in Developing Countries,* London: Earthscan.

http://www.un.org/esa/sustdev/. Cited 26th April 2008.

http://en.wikipedia.org/wiki/Gdp. Cited 26th April 2008.