Renewable energy potentials in Nigeria

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Abstract

Nigeria is an energy resource rich country, endowed with abundance of renewable energy (RE) resources, providing her with great capacity to develop an effective national energy plan. However, Nigeria is yet to exploit these huge available energy potentials with less environmental and climatic impacts. On the contrary, the National energy supply is at present almost entirely dependent on fossil fuels and firewood. These two are being depleted due to failure to harness other energy resources. Substantial progress has taken place in the use of the major rivers in Nigeria and their tributaries to provide hydropower for the country. The total technically exploitable hydropower potential based on the country's river system is conservatively estimated to be about 10,000 MW of which only 19% is being tapped or developed. Currently, solar, wind, biomass, etc are in abundance all year round in Nigeria and largely untapped. For an energy source to be renewed, it means that its harvesting, conversion and use would occur in a sustainable manner and avoid any negative impacts on the people and natural environment. Renewable energy (RE) reality in Nigeria will be dependent on adequate government policy, financial and technical capability and public acceptance for their installation. Renewable energy (RE) resources abound in Nigeria but have not been fully exploited. This presentation examines the state of energy production and utilization; discusses the potentials for renewable energy and major obstacles militating against their developments. The paper also looked at the progress made by Government to remove formal bureaucratic bottlenecks in the sector and consequently attract private sectors to participate.

1. Introduction

Nigeria is endowed with abundance of renewable and non-renewable energy resources. However, the National energy supply is dependent on fossil fuels and firewood. Fossil fuels made up 94% of exports from Nigeria in 2006 with only a small fraction of this available for domestic use. Only about 40% of households in Nigeria are connected to the national electricity grid. Provision of electricity is largely supplemented by private producer or use of individual electricity generators powered with fossil fuel for the privileged income groups. Over 90% businesses and companies have private generators leading to high production cost (Omokaro, 2008).

The present dependence on fossil fuel (petroleum) is not enough to meet the energy needs of the country. Interest in renewable energy development and dissemination in Nigeria is driven by, among others, the recent increase in oil prices, unavailability of electricity to majority of the population as well as high cost and energy losses associated with grid extension. The government had made effort through her several power reform programmes and policies to attract private participation, thus encourage RE development. However, there are hindrances, mainly due to the technical and financial barriers, that need to be overcome for this to be a reality (Sambo, 2009).

2. Energy situation in Nigeria

2.1 Background

The Electricity generation began in Nigeria in 1896 and the first thermal power station was built in 1920. By 1968, the first hydro power station Kainji was built which is a large centrally located

power plant with grid extension (132KV line) to other locations. The Nigeria Electric Power Authority (NEPA) by virtue of the NEPA Act had monopoly of generation, transmission and distribution of electricity in the country. From 1968 to 1991, the installed capacity for electricity generation in Nigeria increased by a factor of 6 to stand at 5881.6 MW. No further addition to generating capacity was embarked upon by the government from 1990 to 1999.

Thus, in 2001, the government started off with reforms, terminating the monopoly status of NEPA and inviting private sector participation in the electricity sector. This reform enabled the development of the National Electric Power Policy in September 2001and later, National Energy Policy (NEP) was approved in 2003. The Renewable Energy Master plan (REMP) was put in place to provide a roadmap for the effective implementation of the renewable energy component of the NEP. A draft national energy master plan (NEMP) was developed by the Energy Commission of Nigeria with support of the United Nations Development Programme (UNDP) in November, 2005. Several workshops and National Stakeholders Forum on RE Technologies have been held and different Memorandum of Understandings (MOUs) signed with private and foreign companies for technical assistance, training and establishment of demonstration projects. However, their implementation depends on investment (Nnaji *et al*., 2010).

From 2005 to present, the government of Nigeria has implemented several independent power projects (IPPs) to boost energy supply in the country. However, the targets for the projects were never met due to problems encountered, such as corruption, bureaucratic bottleneck; inadequate gas supply and obsolete infrastructures (CREDC, 2007). The present Minister of Power has signed Memorandum of Understanding (MoU) with General Electricity Company in London on 18th March 2012 for the construction of power plants and an agreement in April 2012 with Siemens an energy firm to financially support power plants projects and studied on the integration of RE into Nigeria's energy mix.

2.2. Present energy situation

Commercial electricity generation in Nigeria currently comes from 7 power stations and various independent Power Projects around the country. Thus, the current nation's available electricity generating capacity is about 3,920MW with per capita power capacity of 28.57 Watts and this is grossly inadequate even for domestic consumption (Ibidapo-Obe and Ajibola, 2011). For Nigeria to meet up its energy needs, it requires per capital power capacity of 1000 Watts or power generating/handling capacity of 140,000 MW as against the current capacity of 3,920 MW. Consequently, availability of power in the country varied from about 27% to 60% of installed capacity, while transmission and distribution losses accounted for about 28% of the electricity generated in the country (Omokaro, 2008).

The energy consumption mix in Nigeria is dominated by fuel wood (50.45%); petroleum products (41.28%) and hydro electricity (8%). Coal, Nuclear, geothermal, tidal, wind and solar energy are currently not part of Nigeria's energy mix, as they have either been neglected, not discovered or are currently at their early stage of development (Omokaro, 2008). The energy utilization pattern in Nigeria can be grouped into industry, transport, commercial, household and agricultural sectors. Fuel wood is used by over 60% of people living in the rural areas and 80% of Nigerians as energy source. Nigeria consumes over 50 million metric tonnes of fuel wood annually, which is a major cause of desertification and erosion in the country. The rural areas are generally inaccessible due to absence of good road networks, even with the ongoing power reform and privatization of the electricity industry; it is obvious that for logistic and economic reasons, rural areas which are remote from the grid and/or have low power purchase potential will not be attractive to private power investors. Meanwhile electricity is required for basic

developmental services as well as economic growth. The absence of reliable energy supply has left the rural populace socially backward and their economic potentials untapped.

The transport sector is another consumer of oil accounting for 60% of total consumption. Despite the vast oil and gas reserves; small amount is used in Nigeria. The country imports more than 70 percent of domestic fuel requirements because none of the four refineries have functioned efficiently. The high oil import bill exposes Nigeria's energy sector to the external energy price shocks. Nigeria has the 9th largest natural gas reserve in the world and exports large quantities of liquefied natural gas (LNG) to other countries, but her gas-dominated electricity grid still experiences frequent collapse due to inadequate gas supply and obsolete infrastructures. Nigeria flares 75% of its natural gas for lack of processing facilities and that amounts to 12.5% of all globally flared gas (CREDC, 2007).

For Nigeria to meet up with its energy needs, it must look for alternative energy source especially for the rural populace. While it is recognized that RE cannot solve all of Nigeria's energy problems, RE technology is still seen as having a significant unexploited potential to enable the countries to meet their growing energy requirements. If RE is properly harnessed, it could meet a significant proportion of energy demand with less deteriorating effects on the environment.

3. Sources of Renewable energy in Nigeria

3.1. Hydro Energy

The country is reasonably endowed with large rivers and some few natural falls. Small rivers and streams also exist within the present split of the country into eleven River Basin Authorities, some of which maintain minimum discharges all the year round. Hydropower currently accounts for about 29% of the total electrical power supply. In a study carried out in twelve states and four (4) river basins, over 278 unexploited small hydropower (SHP) sites with total potentials of 734.3 MW were identified (Aliyu and Elegba, 1990). However, SHP potential sites exist in virtually all parts of Nigeria with an estimated total capacity of 3,500 MW. They indicate that Nigeria possesses potential renewable source of energy along her numerous river systems, a total of 70 micro dams, 126 mini dam and 86 small sites have been identified. A private company, the Nigerian Electricity Supply Company (NESCO) and the government have installed eight (8) SHP stations with aggregate capacity of 37.0 MW in Nigeria. Most of these stations are found around Jos at Kwall and Kurra Falls. The total technically exploitable hydropower potential based on the country's river system is conservatively estimated to be about 11,000 MW of which only 19% is currently being tapped or developed (Okafor and Uzuegbu 2010). These rivers, waterfalls and streams with high potentials for Hydropower, if properly harnessed will lead to decentralized use and provide the most affordable and accessible option to off-grid electricity services especially to the rural communities.

Disadvantages of hydropower projects in Nigeria:

- Hydropower projects in the Nigeria are associated with huge loans that lead to very high external debt levels and are plagued with allegations of corruption.
- Hydropower development is affected by drought and silting of dams reduces the amount of electricity that can be generated over time.
- Building large dams and reservoirs often harm local ecosystems; involve displacing people and wildlife, and scatters human communities.

3.2. Solar Energy - Nigeria lies within a high sunshine belt and thus has enormous solar energy potentials. Solar radiation is fairly well distributed with average solar radiation of about 19.8 MJm^{-2} day^{-1} and average sunshine hours of 6hrs per day. If solar collectors or modules were

used to cover 1% of Nigeria's land area, it is possible to generate 1850 x10^3 GWh of solar electricity per year; this is over one hundred times the current grid electricity consumption level in the country (Uzoma *et al*., 2011).

Several pilot projects, surveys and studies have been undertaken by the Sokoto Energy Research Center (SERC) and the National Center for Energy Research and Development (NCERD) under the supervision of the ECN. Several PV-water pumping, electrification, and solar-thermal installations have been put in place. Such Solar thermal applications include solar cooking, solar crop drying, solar incubators and solar chick brooding. Other areas of application of solar electricity include low and medium power application such as: water pumping, village electrification, rural clinic and schools power supply, vaccine refrigeration, traffic lighting and lighting of road signs.

3.3. Wind Energy -Wind energy is available at annual average speeds of about 2.0 m/s at the coastal region and 4.0 m/s at the far northern region of the country. With an air density of 1.1 kg/m^3, the wind energy intensity perpendicular to the wind direction ranges between 4.4 W/ m^2 at the coastal areas and 35.2 W/ m^2 at the far northern region (Sambo 2009).

At present, the share of wind energy in the national energy consumption has remained on the lower end with no commercial wind power plants connected to the national grid, Only a few number of stand-alone wind power plants were installed in the early 1960s in 5 northern states mainly to power water pumps and a 5 kW wind electricity conversion system for village electrification installed at Sayyan Gidan Gada, in Sokoto State (Uzoma *et al*., 2011). In recent times, numerous studies have been carried out to assess the wind speed characteristics and associated wind energy potentials in different locations in Nigeria. Promising attempts are being made in Sokoto Energy Research Centre (SERC) and Abubakar Tafawa Balewa University, Bauchi, to develop capability for the production of wind energy technologies.

3.4. Biomass - The biomass resources of Nigeria can be identified as crops, forage grasses and shrubs, animal wastes and waste arising from forestry, agriculture, municipal and industrial activities, as well as, aquatic biomass. Crops such Sweet sorghum, maize, Sugarcane were the most promising feedstock for biofuel production (Nnaji et al., 2010). Plant biomass can be utilized as fuel for small-scale industries. It could also be fermented by anaerobic bacteria to produce a cheap fuel gas (biogases). Biogas production from agricultural residues, industrial, and municipal waste does not compete for land, water and fertilizers with food crops like is the case with bioethanol and biodiesel production and, will reduce the menaces posed by these wastes. In Nigeria, identified feedstock substrates for an economically feasible biogas production include water lettuce, water hyacinth, dung, cassava leaves and processing waste, urban refuse, solid (including industrial) waste, agricultural residues and sewage (Akinbami, 2001). It has been estimated that Nigeria produces about 227,500 tons of fresh animal waste daily. Since 1 kg of fresh animal waste produces about 0.03 m^3 biogas, then Nigeria can potentially produce about 6.8 million m^3 of biogas every day from animal waste only. Although biogas technology is not common in Nigeria, various research works on the technology and policy aspects of biogas production has been carried by various scientists in the country. Some significant research has been done on reactor design that would lead to process optimization in the development of anaerobic digesters (Akinbami, 2001).

Sawdust and wood wastes are other important biomass resources associated with the lumber industry. Small particle biomass stoves already exist for burning sawdust and wood shaving. Biomass utilization as energy resources is currently limited to thermal application as fuel for cooking and crop drying.

Disadvantages

- Increased biofuel production may drive up food costs and even if non-food crops are used, the carbon footprint of fuel production can be significant if intact plant communities are cleared for plant production. There could also compete for land and resources with food crops.

Other Resources

Presently, the potentials of some resources like geothermal, nuclear energy, waves, tidal and ocean thermal gradient still remain untapped and unqualified (Nnaji *et al*., 2010).

Challenges

Despite the recognition that RE are important sources of energy in Nigeria, it has attracted neither the requisite level of investment nor tangible policy commitment. Although the energy reforms and national resources allocated to developing and disseminating RE in the last decades may appear substantial, but the total amount is still insignificant compared to that allocated to the conventional energy sector that service less than 40% of the population. The success of RE technologies has been limited by a combination of factors which include: poor integrated institutional framework; inadequate policy implementation; lack of co-ordination and linkage in RE programmes; pricing distortions which have placed renewable energy at a disadvantage; high initial capital costs of insulation; weak technology dissemination strategies; lack of skilled manpower; poor baseline information on location and weak maintenance service and infrastructure

Way forward

Though initial cost of installation of RE devices is high but the life cost is competitive with conventional energy sources. Government should ensure that fiscal and non-fiscal incentives are put in place for private investors that are willing to invest. The development of RE services should be linked to many other sectors such as agriculture, small scale industrial enterprises or millennium goals. They will have greater likelihood of success if implemented in line with these activities to ensure sufficient demand for the energy services providers and may attract funding.

Experience has shown that most renewable energy technologies (especially those that can be locally manufactured) require subsidies only in the initial stages, and can become financially sustainable in the short to medium term after a certain level of technology dissemination has been attained and subsidy would be gradually withdrawn.

Nigeria now has a published energy policy and the policy did emphasize the development RE. However, integrated policy and vigorous implementation strategy is needed to facilitate rapid diffusion of RE in the nation's energy mix.

The current flow of information on RE technologies is inadequate, demonstration projects on various energy forms should be established widely so that the performance and efficiency with which services are delivered be exhibited. This will sensitize the public as well as assist in the creation of markets for RE system.

The need for capacity building both at institutional and personnel level for acquiring technical, organizational, and managerial skills required for increased development of renewable energy should be identified. Activities such as entrepreneurship and managerial skills development training programmes and technical courses in RE technologies with a view of developing Energy Service Companies for providing services to rural areas need to be introduced. The existing Research and Development centers and technology development institutions should be adequately strengthened to support the shift towards increased renewable energy utilization.

Finally, Nigeria is endowed with abundance of RE resources and these resources could be harnessed along side with energy efficiency to stimulate her economic growth and social development as well as energy sustainability.

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