

Renewable Energy Development as a Solution to Rural Electrification in Nigeria

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Abstract

The ratio of electricity generated through renewable energy sources in developing and least developed countries, barring a few, are not at all significant, as due to lack of sophisticated technology and scarce financial resources. The problem of electricity in most of the African countries, despite having abundance of potential of wind and intensity of the sun is more than most part of the developing world. Most of the developing countries, including African countries get renewable energy between 1 to 3 percent. They squarely depend on gas and coal, with or without certain alternative energy sources, for power generation. Nigeria is no exception to this. In this paper, the condition of rural electrification in Nigeria is analysed with the intention to provide viable solutions for the development and provision of energy in order to reduce electricity problem among the local communities, to encourage industries with the help of the government to have some power generated from renewable energy sources, especially through PV panels, so that the burden on the central power generation sources could be reduce. The efficient electricity for the small scale industries via this source will alleviate the massive unemployment rate in the country. In view of these, the paper also examines the Nigerian power generation mix and use the idea of energy diversification method resorting to renewable energy sources readily available in the country in providing electricity in the Nigerian rural areas.

Keywords: Energy Mix, Energy efficiency, Renewable energy sources, alternative energy sources, rural electrification

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1. Introduction

Sustainable energy has proved to be an important tool, be it from whatever source, in all countries, developed and developing, for their sustainable development. Nigeria is a country located in the West Coast of Africa with abundant sources of energy in both hydrocarbon (Oil, Gas, Coal, and Tar sand) and non hydrocarbon (Wind, Solar, Fuel wood, Hydropower, Hydrogen, Biomass, and Geothermal). They are readily available in the country. At the moment, the sources of energy exploited are the conventional ones, which cover about 70 percent of the country's power needs. Thus, oil and gas industry in the country is the most viable industry with an estimated oil reserve of 33 billion bbl, 2.7 billion tonnes of Coal and 4502.4 billion m³ (159 trillion scf) reserve of natural gas.³

It is a fact that energy is vital for the vast socio-economic activities provided it is backed by a viable law and policy, which is possible only if the governments have enough political will to ameliorate the conditions of their people. It will, in turn, improve the overall standard of living of their people, especially who are indigent and cannot afford a respectful life.

The governing laws in Nigeria on the energy sector, pertaining to generation and supply, in the country have many lacunas. The country is concentrating more on the development of oil and gas sector and has left out the areas of renewable and alternative energy sources almost unexploited.⁴ The gas produced in the country is mainly the gas produced during the exploration of crude oil. It is not at all a sustainable approach. This warrants the need for the development of the liquefied natural gas for the benefit of the citizens and reduction of gas flaring from the oil exploration process which pollutes the environment. In fact, this industry generates employment and brings about economic growth, which will work alleviating the poverty. The country's huge potential exploitation of the renewable energy sources are still hugely underexploited due to the lack of all encompassing energy policy and legal and institutional framework for its growth.⁵

³ Yamusa II, S.U., Ansari A. H., Mustafa M., "Challenges to Policy Implementation in Renewable Energy Development in Nigeria", in *Pensee Journal*, Vol. 75. No. 11, Nov2013, Pp. 374-383.

⁴ *Ibid.*

⁵ Shehu Usman Yamusa II and Abdul Haseeb Ansari, "Renewable Development in Two Selected African Countries: An Overview and Assessment, in *RELP (Renewable Energy Law and Policy Review)* Vol. 4, No. 2/2013 (Country Report) The Legal Publisher Lexxion, Berlin Pp. 151-156.

Maximizing renewable energy sources in rural areas, especially through photo voltaic cells and mini-hydro, is the best option for the provision of rural areas with electricity. For this purpose, the idea of giving independent power producer (IPP) status to bunch of rural folk in various potential areas is the best choice. This is already there in many countries, including India, China and Netherlands, South Africa, Thailand and Malaysia. Since it can be done off the grid, it brings about energy self reliance among the rural folks. It will readily make available electricity to the rural communities for household usages and running small scale industry as well. In view of the foregoing, the paper examines the Nigerian energy generation mix and proposes a possible solution to rural electrification through the use of available renewable energy sources in the country.

2. Nigerian Energy Policy 2003

The Nigerian national energy policy started from a conference in 1978 when Olusegun Obasanjo, a military leader, who controlled all affairs in the country. During the conference, he declared that energy, in all its ramifications, emerged in the consciousness of the country as a crucial element and it was unavoidable for the development of country's industry in particular and socio-economic development in general.⁶

In 1987, the energy guidelines came out with an objective to achieve the development of good energy mix resources available in the country with environmentally acceptable means that will provide for self-sufficiency and security in the energy sector. This came together with the development and maintenance of a regular record of the energy resources. This aimed at to protect the quality of the environment as well as the community and to exploit as well as utilise the natural resources in a sustainable manner.⁷ This led to the setting up of the Energy Commission of Nigeria in Abuja and various energy centres in the country, i.e. Ahamadu Bello University Zaria, University of Nigeria Nsukka and Obafemi Awolowo University Ile-Ife.

⁶Energy Policy (2003) (Nigeria) <www.onlinenigeria.com/geology/?blurb=514> (viewed on 12 October 2014).

⁷Ibid.

This development had the primary intention to develop the energy sector in the country and did not aim at rural electrification. However, this assisted the development of the conventional energy sector on the country fulfilling its energy needs even today. The money generated from fossil fuels, which the country has in abundance, has covered the face of the country from the development of more sustainable energy sources. It is for this reason that there is not any viable policy on the development of renewable energy sources. The environment is being degraded because of excessive use of fossil fuels, which is causing destructive climate change effects in the form of drought and deluge. Thus it a pressing need that Nigeria, along with other developing countries, must make their fullest efforts to harnessing the renewable energy sources in the country. The Energy Policy of 2003 also did not do much in this direction. It was supposed to be reviewed in 2007, but it left like this. It is now overdue and must be reviewed keeping in view this imperative. The Policy should fairly cover the area of power generation and supply with an added emphasis on maximising the renewable energy sources with the help of developed countries and some developing countries like Thailand and India. Thus, overall drive of every energy policy should to provide optimal utilisation of the country's energy sources.

In the Nigerian energy policy, renewable energy sources should have a place like oil and gas and should help fulfil energy needs of the rural folk. Furthermore, sufficient fund should be provided for its development in order to make them not solely depending on the utility sector. The fund can be utilised in establishing, maintaining and training of the rural folk alternative energy sources. This will help the country in achieving the sustainable energy goals. Indians are recording success in the use of renewable sources for providing electricity in a number of villages by the Ministry of Renewable Energy. In 2012, about 100,000 villages were provided with light in Indian from these sources. The small scale industries have immensely benefited, and consequently this has also assisted in the reduction of unemployment rate in the country.⁸

The Energy Policy 2003 has a number of objectives pertaining to renewable energy sources, but they are like toothless bulldog.

⁸Government of India, 13/14/2011-12/RVE, Ministry of New and Renewable Energy Remote Village Electrification Programme.

These objectives include: increasing the percentage of hydroelectric sources and their extension to the rural areas; conservation of the forest resources of the nation; development of the solar capability of the nation's energy mix: promotion of the biomass as an alternative energy source for the rural areas; development of the local capability of the wind energy technology; and keeping abreast of the international trends in hydrogen production as well as its application. It has become clear from the situation on ground that the political will on the part of the government to apply the above policies are totally absent. This is due to the fact that there is lack of competent legal and institutional framework on ground to implement these policy objectives.

3. Nigerian Power Generation Mix

The power generation fuel mix in Nigeria is largely on hydro, coal and natural gas. All other means of electricity generation such as nuclear and renewable energy sources, also which include wind, solar as well as biomass, are in a slow process and, thus, these may not be possible to be used considerably even in the near future. The country does not have a codified law to encourage such sources by providing incentives and regulate renewable energy generation. This prompted this paper which seeks to emphasize on the importance and need of renewable energy sources with an emphasis them to be a viable solution to rural electrification in Nigeria.⁹

Right now, the Federal Government is working out on the plan to exploit more hydropower sources and non-renewable, i.e. coal by installing power plants with better technology that is going to be cleaner at Gombe, Kogi, Enugu and Benue States respectively due to the present of large deposit of coal in these regions. Large resources for fuel to power are from natural gas. Presently, Kainji, Shiroro and Jebba are generating hydro sources. All the plants mentioned are not producing up to their installed capacities due to poor maintenance.¹⁰

The oil producing companies have their independent electricity generation plants in the country. Some states such as Lagos, Jigawa, Nasarawa and Rivers have initiated projects to generate electricity by renewable sources.

⁹Yinka Omorogbe, (2003) Energy Law Supplement 5 Monograph on Nigeria, Blanpain R., Deketelaere K. (ed) International Encyclopaedia of Laws Energy Law, Kluwer Law International, Hague/London/New-York.

¹⁰Ibid.

However, all of them are still in the process of completion due to unnecessary delaying bureaucratic system of the Government.

The National Electric Power Authority (NEPA, which is now known as PHCN), a government-owned electricity company, have the following eight generating plants:¹¹

- (a) Hydropower Station (Kainji) with 580 MW is located in Niger State along River Niger. This is not used to its installed capacity.
- (b) Hydropower Station (Jebba), which has installed capacity of 540 MW, is in Kwara State.
- (c) Hydropower Station (Shiroro) is in Niger State and it has installation capacity of 600 MW.
- (d) Afarm Thermal Power Station has 700 MW installed capacity and is located in Port-Harcourt, River State.
- (e) Delta Thermal Power Station with 976 MW as installed capacity located at Ughelli, Delta State. It uses the natural gas.
- (f) Sapele Thermal Power Station with the total installation capacity of 1020MW in Ogorade, Delta State.
- (g) Egbin Thermal Power Station has 1320 MW installed capacity located on the outskirts of Lagos State.
- (h) Ijora Thermal Power Station located in Lagos with 60 MW installed capacity. It uses AGO.

But all the plants are not working to their full capacities. Presently, the government is working towards the rehabilitation of circa 1,000 MW generating capacity.

It is also planning to add 1,266 MW generating capacity from the new Nigerian Independent Power Project (NIPP). This power station is to be completed in 2013. By December 2013, the country is expected to increase its power supply with a total generating capacity of 4,500 MW from both the Independent Power Project (IPP) and the Power Holding Company of Nigeria (PHCN). Therefore, with the ongoing upgrade of the old engines and the power generation from both the private sector, the country is hoping to get a generating capacity of 14,000 MW power by December 2013.

¹¹Ibid.

Though majority of the generating capacity is expected from private sector, the government has limited investment by financing production of power from coal and renewable sources of power generation through hydro. The financing is in the form of differential wholesale tariffs and it is not a direct capital injection by the government.¹² All these may not benefit the rural electrification programme. The possible way out for the government is to concentrate on the use of renewable energy sources particularly the solar, wind and biomass for the development of rural electrification in Nigerian villages.

3.1 Transmission

The rehabilitation of the transmission network in Nigeria has not been fully completed and the system does not cover all parts of the country.¹³ It makes the system less efficient and has the capacity of 4,000 MW.¹⁴ It has about 5,000 Km of 330 KV lines, 6000 Km of 132 KV lines, 23 330/132 KV substations and 91 132/33KV substations. The electricity supply and transmission is governed by the Electricity Supply Regulatory and the Electricity Wiring Regulations. The transmission company is to provide:¹⁵

- (a) The handling of the transmission of power on an open access basis subject to regulated transmission tariff.
- (b) Manage system operation and dispatch.
- (c) Manage the settlement system.
- (d) Trans-company takes care of all power lines of 132KV and above.

Therefore, the company is confirming only to the electricity transmission and thus it cannot generate, distribute or sell.

¹²Country's Report on 50th Independence Anniversary, 2010, at 774 -795.

¹³ A. S. Sambo, B. Garba, I. H. Zarma and M. M. Gaji "Electricity Generation and the Present Challenges in the Nigerian Power" <www.worldenergy.org/documents/congresspapers/70.pdf > (viewed on 1st December 2014).

¹⁴ Ibid.

¹⁵Country's Report, n. 12 at 774 -795.

The transmission company approves the structure for the system operator to operate electricity network. The transmission company equally acts as energy carrier and the independent power operators.¹⁶ The company is to:¹⁷

- (a) Generate, scheduling, commitment and dispatch;
- (b) Transmission and congestion management;
- (c) Internal, transmission and coordination;
- (d) Procurement and scheduling of ancillary services and system planning for long term capacity;
- (e) Administration of the wholesale market including the administration of the settlement of payments in accordance with the market rules; and
- (f) Such other activities that may be required for reliable and efficient system operation.

For the purposes of improving the generating capacity, the government is trying to improve by 30% increase in the deliverance and transformation capacity of the country's 330 KV network in the period of 2010-2012 in order to go above its current limit of circa 4,500 MW equivalents. In practice, it is difficult to meet up with this target. The same target was fixed by the government for July 2011 but failed. The government try to achieve the target in December 2012 but failed again.¹⁸ This seems not to be achieved by the end of 2013.

The country's transmission network is still weak in the electricity supply chain. The gap between the generation and the capacity of the grid is wide and also increasing considerably. The government needs to provide solutions to this shortcoming. It is also mulling to improve its legal framework for the encouragement of security and efficiency in the provision of power. At the moment, the government is building a new super transmission network.¹⁹ The government is also planning for a cost reflective tariff.

¹⁶James Katende, and Frank, N. Okafor, "Automatic Generation Control Performance of the Nigerian Power System after Deregulation", www.covenantuniversity.edu.ng/content/download/1151/9124/file/agcnigeria1 (viewed on 3rd December 2014), at 1

¹⁷Country's Report, n. 12 at 774 -795.

¹⁸Ibid.

¹⁹James Katende, n. 16

There is a high expectation that the private sector might provide the bulk of the capital investment for the super grid through the revenue generated by the electricity market by using a system charge paid to Transmission Company of Nigeria (TCN).²⁰ The TCN concessionaire area is to invest in the reliability and stability for infrastructure in the network. For providing integrity and reliability system in the grid, the changes include three parts, i.e. the first part is 132 KV to 700 KV in Afam River, Makurdi-Jos-Kaduna-Shiroro-Jabba and to Lagos; the second part is Benin-Onitsha-Alaoji and to Afam; and the third part is Kano-Jos and to Gombe. This is also meant to provide power quality and systems stability.²¹

Generally, transmission in the country needs adequate funding, wide coverage of the country, expansion of its capacity, upgrade of the outdate sections, security to avoid vandaliastion of its lines, mordern technology for better voltage, training and tools for the staff, improved communication system, importation of transformer and equipment for better productivity.

3.2 Distribution

The distribution infrastructure is seriously dilapidated and needs rehabilitation. It requires capital intensive set up, professionalism and efficient management to meet with an acceptable standard. The government needs to privatise the distribution companies in order to bring efficiency and efficient management under the Electric Power Supply Reform (EPSR) Act 2005.²² Privatisation is still in the process. It needs an appropriate legal framework to make it more effective. The problem of transparency and accountability in the system is also crucial to be addressed for the healthy growth of the industry.

Electricity distribution is governed by the National Electric Power Authority (NEPA) Act 1972. NEPA used to be the sole distributor until 1998, when other companies (PHCN) where allowed to participate in the distribution process.²³ But till now, the distribution by other companies has not properly been kicked off. The privatisation process is still ongoing as there is stand still which nobody can explain.

²⁰Ibid.

²¹Ibid.

²²Ibid.

²³Ibid.

Until after privatisation, things might not take shape at the moment and the bureaucracy in the process is not helping the matters.

Generally, problems ranging from poor billing with inaccuracy, low moral staff and insufficient funds for maintenance, substandard distribution lines, overloaded transformers, bad feeder pillars and inadequate network coverage is facing the distribution and marketing disco.²⁴

By the time privatisation takes place, private companies might be charged with the responsibility of distribution through issuance of licenses. The license will specify the designated franchise area within which a company may operate. The privatisation and participation of the private sector would enhance the distribution process.

The distribution company is not allowed to participate in the generation of energy. Where such company is allowed, it might not be more than 10-25 MW. The government is planning to improve distribution and reduce the aggregate distribution losses by 5% (technical and non-technical) before privatisation. It also plans to improve the average number of hours of electricity supplied to the consumers. This may be done with the help of NIPP and PHCN. Although the budget for the above improvement has been provided in 2011, till date the work is not completed since it has not been properly implemented.

3.3 Electricity Market

The country has potential for a huge electricity market as only about 40% of the 158.3 million populations enjoy power supply in major urban centres with very poor distribution network with bad voltage.²⁵ During the monopoly of NEPA, the market was minimally treated and NEPA was the only option for consumers in the country. Another option is to use the generators or small individual solar photovoltaic cells. Consumers of NEPA paid fixed tariffs at the end of every month. In the rural areas, where they have access to electricity supply, very few of them paid their electricity bills. Sometimes, in both the urban and rural areas, there are challenges of illegal connections which need to be checkmated through the instrument of the law.²⁶

²⁴A. S. Sambo *et al* n. 13 at 13.

²⁵*Ibid.* at 13

²⁶Yinka Omorogbe, n. 9 at 43-44.

The poor state of the electricity in the country has made most of the industries to generate their own electricity through the use of generators, which consume diesel and pollutes the environment. The charges for the consumers of electricity in the country are based on a uniform price system, depending on whether it is industrial charges or household charges. The charging system in the country is that the households pay fewer amounts than the industries. However, some consumers enjoy electricity without payment due to illegal connections. The collection is poorly done by the government. NEPA (PHCN) is being substantially owed by its consumers. For example, in 1995, about NGN 8.7 billion was owed by the consumers, representing about 10 months bill. The government subsidises the tariff. It is done through the purchase of gas by PHCN. For example, PHCN bought its gas at NGN 12.94 per 1000 scf, that is, about 8 cents per 1000 scf while the commercial rate is NGN 194-210 per 1000 scf (about 11.20 cents) as of 2003.²⁷

In a nutshell, the country has to improve the weak distribution network for efficiency, provide good feeder pillar, reduced the overload on the transformers, provide efficient standard lines for distributions, set up reliable billing system, create good customer relationship, and facilitate enough monitoring equipment.

4. Electricity Reform

The government has just started privatisation of the electricity sector in the country. The generation of power was unbundled with several generating and distribution companies. This was done through the issuance of licenses with which they will operate. The Federal Government allowed the generating and distribution companies to be 100% private.²⁸ There are six generating and ten distribution companies which are operated and maintained by private companies. Section 60 (1) of Electricity Power Reform Act 2001 provides for such system to be adopted. The BPE has received \$335.85 million from the 16 preferred bidders from both distribution and generation companies.²⁹

²⁷Ibid.

²⁸James Katende *et al* n. 16 at 1.

²⁹Kayode Ekuyode, FG Hands Overpower to private firms in 2 weeks: Anyin, Daily Trust Nigerian Newspaper (Friday, 25 January 2013), <www.dailytrust.com.ng/index.php/bussiness/49272-fg-har> (viewed on 25 January 2013).

The generating companies (Genco) are:

- (1) Shiroro Hydropower PLC (North South Power Limited paid \$16,748,180.00);
- (2) Kainji Hydropower PLC (Mainstream Energy Solutions paid \$35,680,500);
- (3) Sepele Power PLC (CMEC/EURAFRIC Energy Ltd paid \$30,150,000.00);
- (4) Geregu Power PLC (Amperion Power Distribution Limited paid \$19,800,000.15);
and
- (5) Ugheli Power PLC (Transcorp/Woodrock/Sumbion/Medea/PSL/Thomassen paid \$45,000,000).³⁰

The following are they distribution companies. They include:

- (1) Abuja Disco (Kann Consortium Utility Ltd paid \$24, 600,00);
- (2) Benin Disco (Vigeo Power Consortium paid \$19,350,000.00);
- (3) Eko Disco (West Power & Gas paid \$20,250,000.00);
- (4) Enugu Disco (Interstate Electrics Ltd paid \$18,900,000.00);
- (5) Ibadan Disco (Integrated Energy Distribution and Marketing Ltd paid \$25,350,000.00);
- (6) Ikeja Disco (NEDC/KEPCO Consortium paid \$19,650,000.00);
- (7) Jos Disco (Aura Energy Ltd paid \$12,300,000.00);
- (8) Kano Disco (Sahelian Power Ltd paid \$20550,000.00);
- (9) Portharcourt Disco (4Power Consortium paid \$18,636,306.000); and
- (10) Yala Disco (integrated Energy Distribution and Marketing Ltd paid \$8,890.000).³¹ The Federal Government will be handing over very soon.

The upgrade of the 330 KV lines and 132 KV lines to 700 KV line is ongoing and it is also part of the reform. In transmission, the reform recommended for only one transmission company to carry the grid construction, operation and maintenance of the transmission system in the country. The company may be responsible for all power lines for 132 KV and above.³²

The transmission company is not involved in power generation. The company will remain 100% state-owned. The electricity network have only one system regulator. The transmission company is the system operator.

³⁰Ibid.

³¹Ibid.

³²Country's Report, n. 12 at 774 -795.

In the reform, the electricity is purchased, sold and traded under the guidance of the Nigerian Electricity Regulatory Commission through a trading license. The purchase can be made from IPP and to be resold to the other licensees or eligible customers.³³

5. Consumption

Despite the population of 158.3 million, the country's per capita electricity consumption is very low. According to the statistics from the National Electricity Policy, only 40% to 60% of Nigerians have access to electricity.³⁴ As of December 1995, over 2.5 million were registered as consumers of electricity in the country. The statistics reveal 2.1 million are residential customers, (400,000) are commercial, (33,000) are industrial and only (3,000) for street light customers.³⁵ The country is in dire need of electricity because of its vital role in the development of technological and socio-economic activities.³⁶ The demand of electricity in the country is more than the supply. Development cannot take place without electricity and therefore it must be improved.³⁷ The government needs to do something in structuring the issue of electricity in the country. The country has a low requirement of electricity during office hours and high in the residential consumption. The inadequate supply of electricity for an average business may lead to the avoidance of any business that may require electricity in the country.

It is important for electricity to be self-sustaining in the country after privatisation. The prices and charges might be market-driven due to competition if the success of privatisation is recorded. Nigerian Electricity Regulatory Commission is to regulate the tariff structure to ensure that prices are cost-oriented. It should be in such a way that both the parties are protected, i.e. the competitors and consumers. There should be upward review in the tariff to achieve operating cost and full cost that include normal as well as risk adjusted rate of profit for the new investment to cover the total cost. This should be done gradually.

³³Ibid.

³⁴Abubakar S. Sambo, (2009) "Strategic Developments in Renewable Energy in Nigeria", paper presented at International Association for Energy Economics, Third Quarter 2009, at 1.

³⁵Yinka Omorogbe, n. 9 at 43-44.

³⁶A. S. Sambo *et al*, n. 13 at 4.

³⁷Ibid.

The country has the potential in the growth of the consumption of electricity. Therefore, the electrification of the places unconnected is very important as it might maximise the profit and generate more income for the investors.

The Energy Commission through the use of Model for the Analysis of Energy Demand (MAED) were able to come out with a four economic scenarios which are as follows:

- (1) Reference Scenario - 7% GDP Growth;
- (2) High Growth Scenario - 10% GDP Growth;
- (3) Optimistic Scenario I - 11.5% GDP Growth; and
- (4) Optimistic Scenario II - 13% GDP Growth (this was based on the Presidential Pronouncement for the desire to be among the first 20 economies by 2020).

The actual driving parameter used is the economic growth and structure in the above scenarios. The projection is done based on the demand for grid electricity and peak demand, which assumptions was used and made for transmission and distribution, losses, consumption auxiliary, load factor with the failing non grid generation.³⁸ Table bellow presents the electricity demand projections per scenario for 2005 to 2030 based on a presidential pronouncement.

Table: Electricity Demand Projections per Scenario, MW³⁹

Scenario	2005	2010	2015	2020	2025	2030
Reference (7%)	5,746	15,730	28,360	50,820	77,450	19,200
High Growth (10%)	5,746	15,920	30,210	58,180	107,220	192,000
Optimistic I (11%)	5,746	16,000	31,240	70,760	137,370	250,000
Optimistic II (13%)	5,746	33,250	64,200	107,600	172,900	97,900

Based on the above table, it is clear that the country will need 297,900 MW in the year 2030 with the 13% increase in the GDP rate. In using the base year 2005, this shows that the country will have to generate 11,686MW yearly to meet up with the country's demand.

³⁸Ibid, at 6.

³⁹A. S. Sambo, "Matching Electricity Supply with Demand in Nigeria" International Association for Energy Economics, (Fourth Quarter, 2008), at 32-36.

This is a big market for the investor and therefore Nigeria is country that power producers should invest their capitals for a better return in the future.

6. Rural Electrification

The ongoing electricity reform has issues related to rural electrification in the country. These include both the grid and off grid, minim grid and alternative sources. The Federal Government should encourage the Local Governments and business developers to get involve in rural electrification for the benefit of the citizens in the rural areas and development of local industries.⁴⁰ This is where the raw materials are found and it will invariably provide employment opportunities in the areas.⁴¹

Presently, the rural areas in the country depend on fuel wood, which constitutes 60% of the population in the country. About 50 million metric tonnes of fuel wood is used annually. This has exceeded the replenishment rate. This is a major cause for desertification in the country, as about 350 hectares are used per year for fuel wood which is about 3.6% of the present area of forest and wood lands. The present government programme on reforestation is just about 10% of the 350 hectares used per year for fuel wood in the country. The government must come up with a strong policy to protect the country since Nigeria is a member of convention on desertification.⁴²

The ongoing power sector restructuring and privatisation of the electricity must strongly develop electricity in the rural areas. In places which are too remote to be connected to the national grid, the government should introduce the use of renewable energy. India is doing this to promote electricity efficiency in the villages. The introduction of renewable energy is the best and the easiest way for solving the country's electricity problem. Therefore, the law for the generation of electricity through renewable energy should be enacted to regulate electricity generation and supply through renewable sources in the country. The use of renewable energy can be from different sources such as the following.

⁴⁰Umar I. H., Iloeje O. C., and Bala E. J., (2000) "Review of renewable energy technologies in Nigeria", Vol. 8, No.'s 1 & 2 Nig. J. Ren. Energy, at 99-109.

⁴¹Country's Report, n. 12 at 774 -795.

⁴²Abubakar S. Sambo, n. 34 at 15-16.

6.1 Solar

The country's location in the West Coast of Africa and around the equator has advantages of solar radiation. It has an annual average total radiation of about 12.6MJ/m²-day in the coastal latitudes to about 25.2MJ/m²-day in the northern part of the country.⁴³ This is one of the high potential renewable energy sources that can massively be used in the village areas. It can be use off grid and therefore easily accessible to the rural areas. Photovoltaic (PV) cells can be used to give light to the villages, small industries and farm houses. The use of solar is very environmental friendly. The country can also use solar for big industries if the storage facilities is provided. Although these are a bit of expensive at the moment, it will become cheaper to use the solar energy sources for electricity generation after putting environmental effect of the other conventional sources of energy.⁴⁴ The country can generate over 427, 945 MW of solar energy if there are adequate storage facilities. Solar energy can also be used for the purpose of providing energy for water pumping, refrigerators, heating, crop drying and cooling at the villages in the country. At the moment, Indian government, through the Ministry of Renewable Energy, is working hard to provide electricity in all the villages and therefore a left let of this can be applied in Nigeria. Since village folk are generally poor, they require proper financial support and operational training for optimal use of the cells installed by them. They can also be encouraged to produce electricity from this source on cooperative basis. This will fulfil their energy needs and will also help to protect the trees.

6.2 Biomass

Nigeria has abundant biomass in the villages from wood, forage grasses waste bacteria, animal waste, shrubs, waste from agricultural and forestry.⁴⁵ The estimated biomass in the country is very significant and it can be used as fuel in thermal power plants. It can also be use in sustaining household needs such as cooking, boiling water and heating the houses. It can be use for small scale industries in the Nigerian villages.

⁴³Nigerian Energy Policy (2003).

⁴⁴Umar, I. H., (2004) "Overview of renewable energy in Nigeria: Opportunities for rural development and development of Renewable Energy Master Plan". Paper presented at the Renewable Energy Conference, Energetic Solutions, Abuja/Calabar, 21-26 November, 2004.

⁴⁵Ibid.

Biomass, like the solar cells, can easily be used off the grid in the country's rural areas.⁴⁶ A comprehensive programme can be properly arranged in the rural areas and this can heavily reduced the load-shedding in the country. There is a need to promote research and development in the area of biomass and promote manpower training to maintain the biomass programme in the villages. This will also assist in reducing unemployment rate in the country. Therefore, the country should harness the non fuel wood biomass energy sources as it will also help in reducing desertification in the country.

7. The Way Forward for the Rural Electrification Programme

The way forward for the rural electrification programme is the exploitation of renewable energy resources discussed above through an efficient policy with a programme that has plan of action to be followed for the provision of light in the Nigerian villages. In every programme, there should be objectives basically for proving light through the use of renewable energy sources that are readily available in the villages and the light should be provided where grid connectivity is costly or not feasible. The programme can be divided into stages.⁴⁷

In putting a plan to implement the programme, there should be intention to provide light point that will be about 8 W each and one to two socket with 35-40 W in a household to be used for electronic gadgets. The light may be provided in a mini/micro grid mode with flexibility of points and each household may be allowed with total 58 W. Where this is not possible, a standalone solar lighting system for each of the willing households in the village should be provided. The street lighting system should have at least 10 W CFC provided in it. The street light system should be considered base on the percentage of the total number of the household in every village where the programme will be provided.

At the initial stage, the statistics of the villages and hamlets, where the need for the provision for electricity is required, must be identified to give the government the total picture of what it will take to provide this amenity.

⁴⁶Umar, I. H., (2004) "Overview of renewable energy in Nigeria: Opportunities for rural development and development of Renewable Energy Master Plan". Paper presented at the Renewable Energy Conference, Energetic Solutions, Abuja/Calabar, 21-26 November, 2004.

⁴⁷ Ibid.

It will also help in knowing the cost effective as well as how the programme will be slotted in the budget and categorisation. This will give the idea of whether the villages and hamlets will get the light base on grouping them in a number or base on individual villages and hamlet. Sometimes, the provision of such light in the villages using grouping method help in having installation of small power plant and min grid, i.e. with capacity of 10 KW to 250 KW per site through various renewable energy sources.

This programme should have awareness campaign in the areas where the programme/project will take place. It is for the purposes of protecting the power installation and payment of maintenance fees. In this situation, the government can provide incentive of up to 90% for the maintenance fees for 5 to 10 years. In doing so, there should be proper implementation by the government to prevent failure. Finally, rural electrification through the use of renewable energy sources readily available in the country will reduce load-shedding and it is the best way out for solving the Nigeria electricity shortages.

All in all, the solar power is the best option for rural electrification. For this villagers should be encouraged to work on cooperative basis. It will require proper planning, investment of money and a support system. The best thing in this is that it does not require any raw material to feed in. Several countries, especially India, South Africa and Philippines are the best example. This requires transfer of environmentally sound technology and financial resources from developed countries to developing countries. There is no other choice. If developed countries are not working on it seriously, the damage caused my climate change might be huge, perhaps, irreparable

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