INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & MANAGEMENT

REVIEW ON THE PAST, PRESENT AND FUTURE OF ELECTRICITY GENERATION IN NIGERIA

Sofoluwe, Adekunle Olushola
Evagreen Professional Services Limited

ABSTRACT

This article sought to review the major electricity generation sources in Nigeria with their production capacity while simultaneously identifying the different problems affecting the power generation. Attempts were made to explore government interventions to minimise the existing challenges while also analysing the prevailing environmental impact of the power generation approach currently utilised as well as the way forward in guaranteeing problem resolution.

Keywords- *Integrated Electricity Generation in Negeria etc.*

I. INTRODUCTION

Electricity has always been the highest grade of energy even though all forms of energy can be transformed into electricity. Energy is vital to growth and development of any economy and essential for our day to day activities which will often take for granted in Nigeria. For centuries now, there has been a spontaneous increase in demand for energy due to increase in population in developing countries and industrialisation (EIA 2010).

Nigeria is the most populous black nation with a population of over 180 million with extensive area of about 913,073 square kilometres. The country's electricity generation started in the year 1896, fifteen years after its introduction in England with the PowerStation located in Lagos State. Nigeria, a republic in western Africa, is bounded by the west by Benin Republic, North by Niger Republic, East by Cameroon and by the South by the Atlantic Ocean. The country is blessed with abundance of both renewable and non renewable energy sources; and is the world's sixth largest reserve of crude oil. Its gas reserves is about 185 trillion cubic feet, coal, lignite 2.75 billion metric tons and tar sand (Ibitoye and Adenikinju 2006; REMP 2007).

Despites all natural resources, Nigeria electricity generation and supply is not impressive with over 60% of the country population experiencing blackout without any connection to the national electricity grid and the remaining 40% population are left with unstable power supply.

The Nigeria electricity market has been critically analysed by different researchers resulting to insightful statements and facts regarding the role of government in the electricity market which has so far have resulted in epileptic electricity supply.

The Nigeria government so far has spent over #5 trillion ($31.45 billion) from 1999 till date just to generate additional 2,500 mega over the last 14 years in addition to the existing electricity generation (World Bank 2011; IEA 2005; FMPS 2006; Vanguard 2013).

Brazil on the other hand, so far have invested $58 billion from 1994 to 2008 to generate 100,000MW of electricity and South African currently generating about 40,000MW of electricity with investment plan of $37 billion that will triple the present generating capacity over the coming years (Vanguard 2013). More instructive is the fact that Ghana recently celebrated 10 years uninterrupted power supply despite been dependent on Nigeria for energy supply

Table 1: Natural energy resources in Nigeria

Energy type	Resource estimate
Crude oil	36 billion barrels
Natural gas	185 trillion cubic feet
Hydro power	14,750 MW
Coal	2.75 billion metric tons
Solar radiation	3.5–7.0 kWh/m^2-day
Wind energy	2.0–4.0 m/s
Biomass	144 million tons/yr
Wave and tidal energy	150,000 TJ/yr (16.6 x 10^6 toe/yr

Sources: Renewable Energy Master Plan, 2007

II. ELECTRICITY GENERATION IN NIGERIA

National Electric Power Authority (NEPA) now known as Power Holding Company of Nigeria (PHCN) generates electricity in Nigeria. The electricity generation is from a high head water storage reservoir, also known as hydro power plant and gas thermal plants even though most of the plants operate well below their design capacities.

Hydro Power Plant

Hydropower plant depends mainly on free gravitational force of falling water for electricity generation. The water is dammed; energy released from the water depends on the volume and the height(head) of the water. The major hydroelectric plant components for power generation are: powerhouse (transformer, generator, and turbine), high head water storage reservoir/dam, transmission lines, penstock and the control gate. The flow of energy in the water turns around the blade of the turbine which simultaneously turns the generator to generate electricity. The electricity generated is step-up by the transformer before been send to the transmission lines and when the demand of energy is low, excess energy is used to pump in water to the higher reservoir or dam and used again when the demand for energy is high (DIERET, 2004). Fig 1 and Fig 2 show a typical hydro scheme and the basic component that makeup hydropower plant.

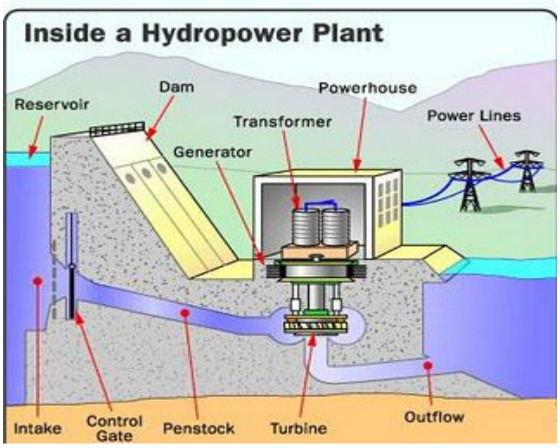

Figure 1: Cross section through a Typical Hydro Scheme

Thermal Power Plant

In thermal power plant, the turbines operate like jet engines drawing air from the atmosphere at the front of the unit, the air is compressed and mixed it with fuel, and subsequently ignited. The hot combustion gases expand through turbine blades connected to a generator to produce electricity. The main parts of gas turbine are: compressors, combustor, turbine, air intake system, exhaust system, starting system and fuel system. The combustor is annular chamber where the fuel burns and is made of alloys that can withstand high temperature. The turbine which facilitates the energy conversion is made of rows of blade which are fixed to the shift and the gas turbine shaft is connected to the generator to generate the electricity. Gas turbine plant can work continuously without any decrease in its output and performance. Fig 3 shows the combustion turbine power plant with its basic components that enable it to function in a full capacity.

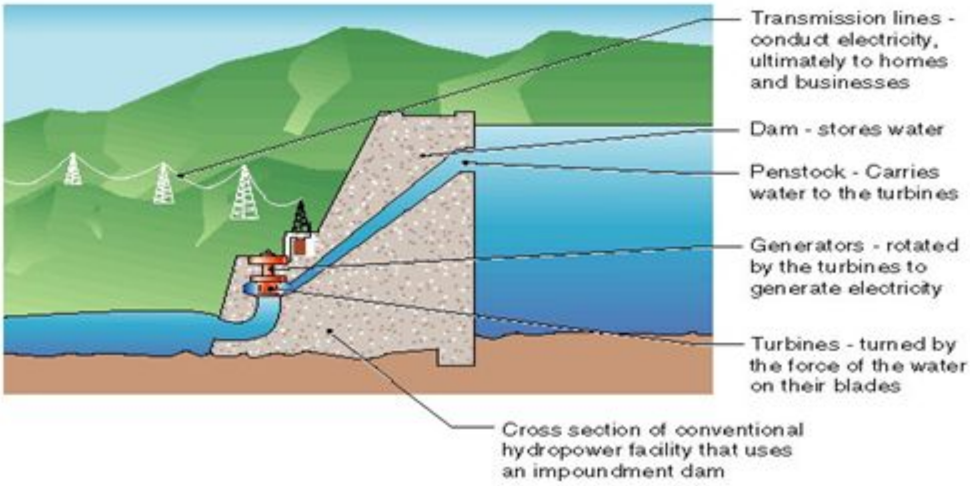

Figure 2: Hydroelectricity Dam Description
Adapted from: Hydro Power [*http://www.inforse.org/europe/dieret/Hydro/hydro.html*](http://www.inforse.org/europe/dieret/Hydro/hydro.html)
http://.instrumentations.blogspot.com/hydroelectric-dam

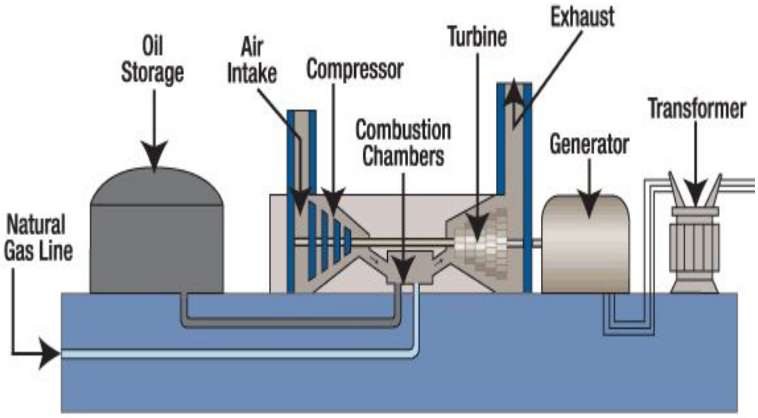

Figure 3 Combustion Turbine Power Plant

III. POWER PLANT GENERATORS IN NIGERIA

There are two kinds of electricity generator in Nigeria, which are: hydro power plant and thermal power plant. The generators are divided into are:

1. Federal Government of Nigeria (FGN) Power Generation Facilities
2. Independent Power Projects
3. National Integrated Power Projects

The hydropower plants generator is Kainji/Jebba and Shiroro hydro power plant and the thermal power plants generator is Ughelli, Sapele, Afam

Kainji/Jebba Hydro Power Plant

Kainji is the first hydropower plant in Nigeria, follow by Jebba in 1968 and 1985 respectively. It is located in Kwara State. The power plants utilise the water that comes from the River Niger. The installed capacity of the two plants is 1330 MW: Kainji 760MW and Jebba 570MW. Kainji currently delivers about 400MW while Jebba contributes 450MW from five (5) units with one down for major repairs. Jebba is the smallest of the three operating hydro power plants in Nigeria.

Shiroro Hydro Power Plant

 ISSN 2277 – 5528
Impact Factor- 3.145

Shiroro power plant is located in Niger State with installed capacity of 600MW and was commissioned in 1990. The annual generation of electricity in year 2009 was 2,282.1 GWh but currently delivers 450MW to the national grid from three of the four units with units 411G2 undergoing comprehensive repairs. Shiroro is also equipped with switchyard facilities that include a technical "step down" function for enhanced distribution into the national grid.

Ughelli Power Plant

The Ughelli Power plant is operated via gas-fired thermal technology located in the Niger Delta region, Effurun-Patani Ughelli Delta State. The plant which began operations in 1966 is the largest thermal generating power station in Nigeria. The installed capacity is 972 MW but currently delivers 550MW.

Sapele Power Plant

Sapele Power Plant is another thermal generating station located in Nigeria's gas rich Delta State. It commenced operation in1978 and is close to natural gas source as the feedstock. Sapele power plant has installed capacity of 1020 MW but only two (2) out of six (6) of 120MW steam turbines are currently operating, producing 200MW. Sapele Power includes a control room and switchgear.

Afam Power Plant

Afam Power Station is located in Rivers State. It commenced operation in 1965 with installed capacity of 776MW but currently generating 456MW. The gas turbine units were installed in phases: 1-4 units in 1963, 5-12 in 1978, 13-18 in 1982. Two gas turbine units were commissioned in 2001 during the final phase of the Afam power station extension and presently none of the installed units are in service. There are plans to bring gas turbines 17 and 18 back into service by Dec, 2012. These units would contribute 127MW to the grid.

Non-Operating Generation Assets

Calabar Thermal Power Plant

Calabar Power Station is located in Marina, Cross River State. It was built in 1934 with installed capacity of 6.6 MW derived from three units of 2.2 MW each and has not been operational for the past 10 years. Calabar Power divestiture will be by asset sale.

Oji River Power Plant

Oji River Thermal Power Station is located in Achi, Enugu State and is the only coal-fired steam power in Nigeria, built to take advantage of the large deposits of high-grade coal. It generated 10MW of power from five coal-fired boilers and four steam turbines originally installed in 1956 and it has not operated for past 10 years, the water from the river is usually used to feed the steam turbines.

Ijora, Power Plant

Ijora Power Plant was commissioned in 1956 with coal-fired boiler, with a good transmission station of 132/33KV. The plant is no longer operational because the 33/11KV transformers require replacement, its location is good for an Independent Power Plant project.

The proposed electricity installed capacity for the three (3) hydro plants are 1939MW, but presently generating 1000MW while for the thermal plant has installed capacity of 5976MW but generate 2589MW of electricity. Table 2a,b,c.d shows the existing generating capacity of each generator. Fig 4 shows the existing and proposed power plant under construction from 2008 to date.

ISSN 2277 – 5528
Impact Factor- 3.145

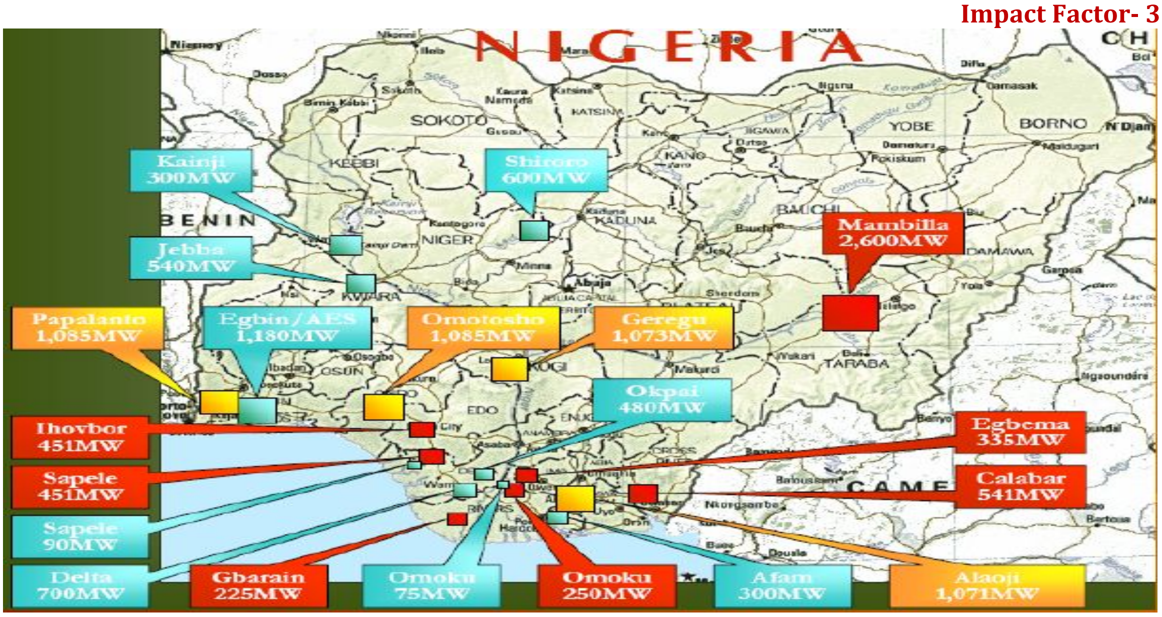

Figure 4: Maps showing Existing and Proposed Power Plant under Construction since 2008. Source: Salihu, 2013

Table 2a: Government Owned Power Stations – Hydro

Name of Generation Company	Year of Const.	Location (State)		Installed Capacity (MW)	Installed Capacity (No)	Available Capacity (MW)
Kainji/Jebba Hydroelectric PLC – Kainji Power Station	1968	Kainji, Niger		760		480
Kainji/Jebba Hydroelectric PLC – Jebba Power Station	1985	Jebba, Niger		540		450
Shiroro Hydroelectric PLC	1989	Shiriri, Niger		600		450
Totals				**1,900**		**1,380**

Table 2b: Existing FGN Power Stations - Thermal

No	Name of Generation Company	Year of Const.	Location (State)	Installed Capacity (MW)	Available Capacity (MW)
1	Egbin Power PLC	1986	Egbin, Lagos	1320	1100
2	Gerebu Power PLC	2007	Geregu. Kogi	414	276
3	Omotosho Power PLC	2007	Omotosho, Ondo State	304	76
4	OlorunsogoPower PLC	2008	Olorunsogo, Ogun State	304	76
5	Delta Power PLC	1966	Ughelli, Delta	900	300
6	Sapele Power PLC	1978	Sapele, Delta	1020	90
7	Afam (iv – v) Power PLC	1963/01	Afam, Rivers	726	60
8	Calabar Thermal Power Station	1934	Calabar, Cross	6.6	Nill
9	Oji River Power Station	1956	Oji River Achii. Enugu	10	Nill
Total				5,004	61978

Table 2c: Independent Power Projects

No	Name of Generation Company	Year of Const.	Location (State)	Installed Capacity (MW)	Available Capacity (MW)
1	AES Power Station	23	Egbin, Lagos	224	224
2	Shell – Afam VI Power Station	2007	Afam, Rivers	650	650
3	Agip – Okapi Power Station	2007	Okpai, Delta	480	480
4	ASG – Ibom Power Station	2008	Akwa Ibom	155	76
5	RSG – Trans Amadi Power Station	1966	Port Harcourt, Rivers	100	24
6	RSG – Omoku Power Station	1978	Omaku Rivers	150	30
Total				**1,759**	**1,484**

Table 2d: Existing Generation Capacity

Plant	Age (Years)	Installed Capacity (No)	Installed Capacity (MW)	Units Available (No)	Capacity Available (NW)	Operational Capacity (NW)
Thermal						
Egbin	23	6	1320	4	880	600
Egbin AES	7	9	270	9	270	220
Sapele	44	10	1020	1	90	65
Okpai	4	3	480	2	480	240
Afam	45	20	702	3	300	130
Delta	18	18	840	12	540	330
Omoku	2	6	150	4	100	70
Ajaokuta	n.a	2	110	2	100	80
Geregu	2	3	414	3	41	414
Omotosho	New	8	335	2	80	0
Olorunsogo/ Paplanto	New	8	335	2	80	0
Sub-total		93	5976	44	3334	2149
Hydro:						
Kainji	42	8	760	6	440	400
Jebba	23	6	540	6	540	300
Shiroro	20	4	600	2	600	300
Nesco	79	8				47
Sub-total		26	1900	14	1580	1047
Grand-total		119	7876	58	4914	3196

Modified from Sources: PHCN, 2007

IV. PROBLEM OF ELECTRICITY GENERATION IN NIGERIA

In 2009, the total installed capacity of electricity was 7,876MW while only 3196MW of electricity was generated due to the problem facing the generators, which include: ageing in power plants, poor maintenance, inadequate of funds, poor infrastructure, load shedding, lack of project continuity (NEPA, 2004). About 60 percent of the population are not served with electricity and per capita consumption of electricity is approximately 100kWh against 4500kWh, 1934kWh and 1379kWh in South Africa, Brazil and China, respectively (IEA, 2005 and FMPS, 2006). Fig 5 shows the electricity generation in Nigeria from 1970-2005.

ISSN 2277 – 5528
Impact Factor- 3.145

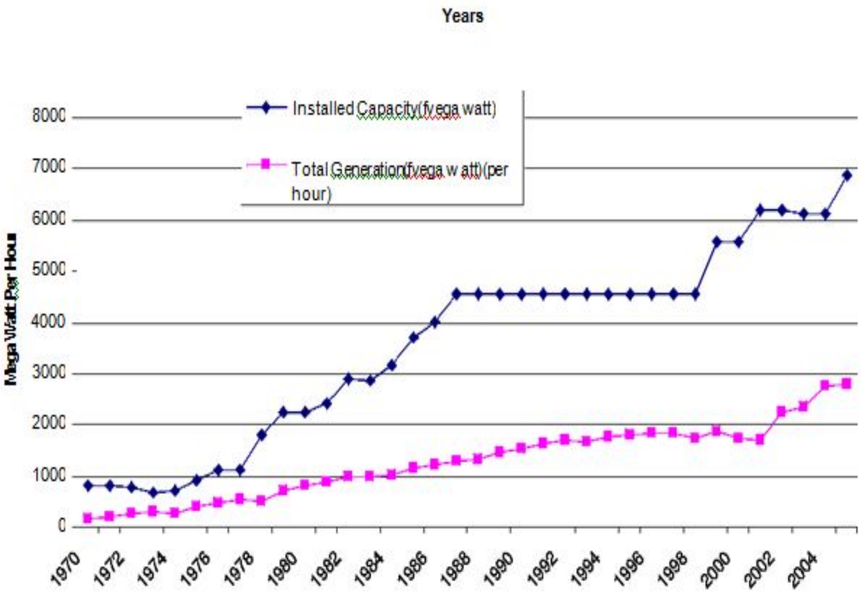

Figure 5: Electricity Generation in Nigeria, 1970-2005. Source: Adetunji 2009. Demand for Residential Electricity in Nigeria

The transmission network for the electricity generation consisted of 5000km of 330 kV lines, and 6000km of 132 kV lines. The 330 kV lines fed 23 substations of 330/132 kV rating with a combined capacity of 6,000 MVA or 4,600 MVA at a utilization factor of 80%. In turn, the 132 kV lines fed 91 substations of 132/33 kV rating with a combined capacity of 7,800 MVA or 5,800 MVA at a utilization factor of 75% (FMPS, 2006). Figure 6: shows the summary of the national transmitting grid system.

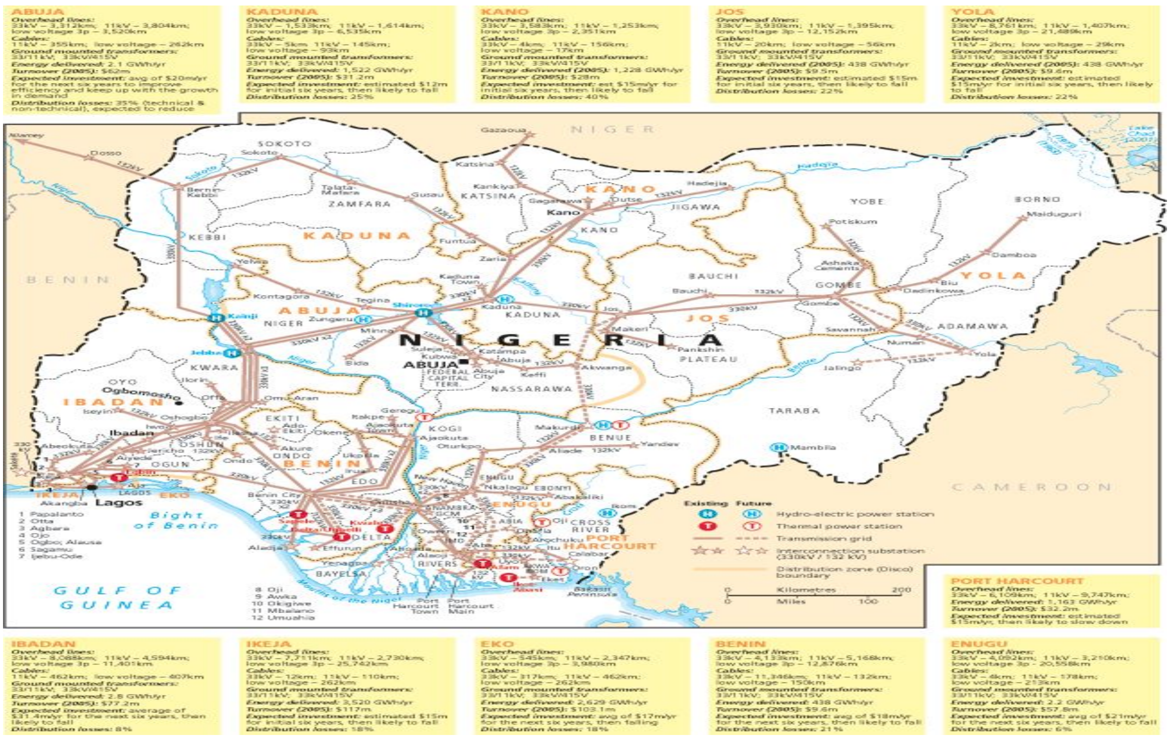

Figure 6: Map showing the Grid Summary system. Adapted from http://www.geni.org/globalenergy/librar/nigeria

The transmission network is overloaded with a wheeling capacity less than 4,000 MW and has a poor voltage profile in most parts of the network, especially in the northern part of the country where there is inadequate dispatch and control infrastructure, radial and fragile grid network, frequent system collapse and exceedingly high transmission losses.

With various power projects under construction to generate 12,500MW and transmit it to the national grid, the country's total installed capacity will be 20,000MW after completion. Presently the transmission lines is design for 4,800MW which infer that even after the generation, 75% of the electricity generation will been lost during transmission to the national grid which rank Nigeria first compared to other countries in the world having the highest transmission lose which is 3 (three) times normal values.
The question is therefore presented; why does Nigeria have such a huge amount of loss during transmission? the question may be best answered via the appreciation of the level of sabotage, illegal connection, poor maintenance and ageing of the transmission lines. Indeed in 2008 alone, 12 sabotage cases were reported on the transmission grid in the country. The distribution grid consisted of 23,753 km of 33 kV lines and 19,226 Km of 11 kV lines. In turn, these feed 679 substations of 33/11kV rating and 20,543 substations of 33/0.415 and 11/0.415 kV ratings.

V. ELECTRICITY REFORM IN NIGERIA

Electric Power Sector Reform (EPSR) Act was signed into law in 2005. Nigerian Electricity Regulatory Commission, National Energy Master Plan (NEMP) and Renewable Energy Master Plan(REMP) were established. This was to encourage the private companies to participate in electricity generation and distribution. The aim of the reform was to refurbish the existing plants to achieve full capacity, rehabilitate the transmission lines to improve the grid's integrity and reduce transmission losses and the use of renewable energy in sustaining national development (ECN, 2007).

Benefits of the Reform

The reform so far has helped to increase foreign participation in electricity generation by Independent Power Producers (IPPs). The IPPs project under construction include 276MW Siemens station in Afam, Agip's 450MW plant in Kwale, ExxonMobil's 388MW plant in Bonny, ABB's 450-MW plant in Abuja, and Eskom's 388-MW plant in Enugu. The government is also embarked on four thermal power plants construction with a combined capacity of 1,234 MW to meet its generating goal of 6,500 MW: Geregu, Alaoji, Papalanto, and Omotosho in Ondo State (Adetunji and Shuiabu, 2007). Although the complete privatization of the generator company (PHCN) was successful in 2010 after 5 (five) years of reform in the energy sector with the government limiting participation in power generation and distribution the transmission lines are still owned by the government although currently managed by private sector. The government is expected to buy electricity from the private generator and sell again to different distribution companies with every selected company having the capacity to generate a minimum of 5000MW. Government will also provide assistance via the provision of credit facilities to enable them to build the various power plants.

Electric Power Sector Reform (EPSR) Act 2005

Electric Power Sector Reform (EPSR) Act, 2005 emphasized the role of renewable electricity in the overall energy mix, especially for expanding access to rural and remote areas. This will help to reduce load on the national grid and save cost to connect them to the grids. Presently only small hydropower, solar photovoltaics, wind electricity is been used. Fig 7: show the electricity generation mix with other sources of energy sources and Table 3: show the future Installed Electricity Generation Capacity mix with fuels.

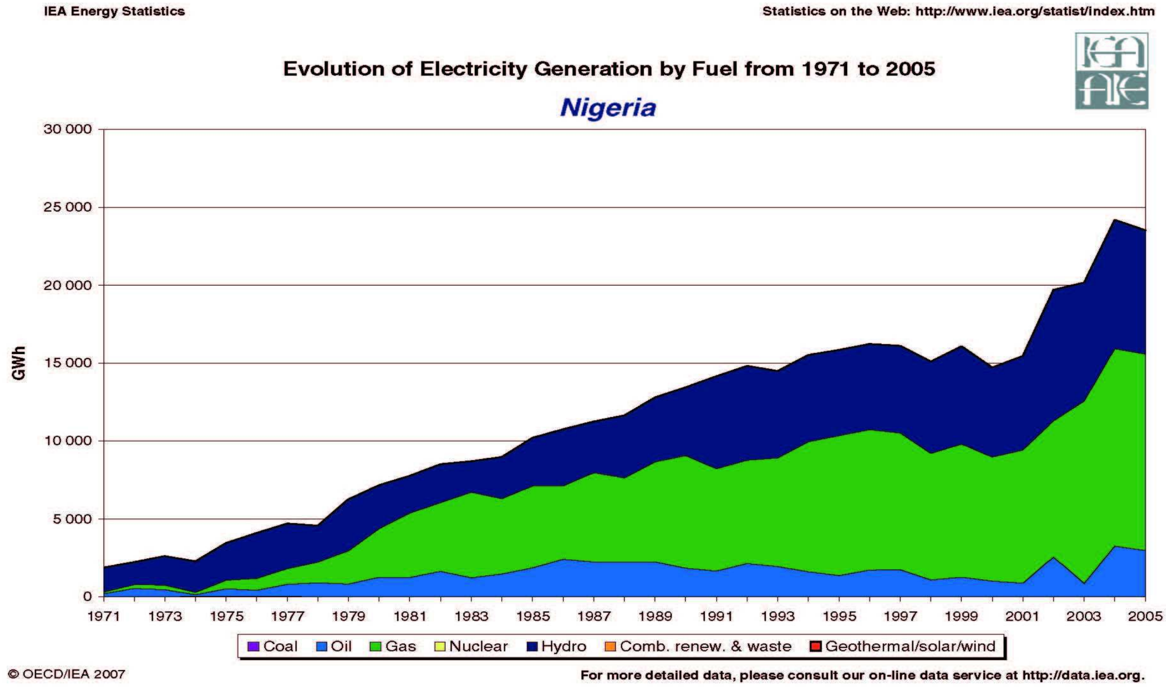

Figure 7: Electricity generation mix. *Source: http://www.geni.org/globalenergy/library/energy-issues/nigeria*

Table 3: Future Installed Electricity Generation Capacity Mix With Fuels

Fuel type	2005	2010	2015	2020	2025	2030
Coal	0.0	0.0	9.9	13,8	15.3	15.6
Gas	68.3	78.6	48.5	53.5	53.0	56.0
Hydro	31.3	21.3	18.9	13.6	10.7	8.6
Nuclear	0.0	0.0	9.4	5.3	8.3	6.7
Solar	0.0	0.1	13.1	11.0	10.4	8.3
wind	0.0	0.0	0.1	2.9	2.3	1.8

Source: IAEA, 2003, 2007

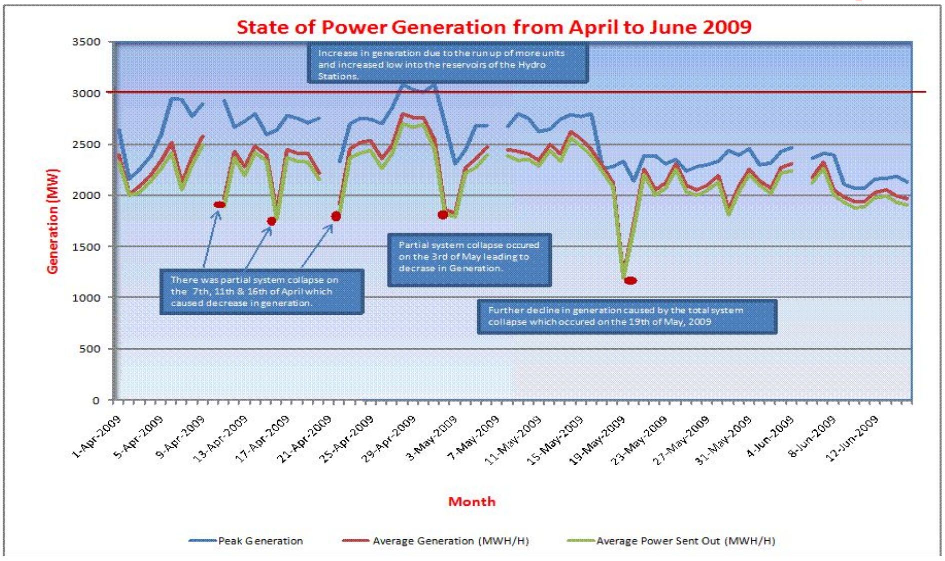

Fig 8 : Electricity Generation from April to June 2009. Source: NERC, 2009

Small Hydropower (SHP)

SHP is located where there is high potential of rivers, waterfalls and streams. This will help the rural areas to use their own local natural resources which will help to provide off-grid electricity. Nigeria SHP is between 2MW to10MW. Recent studies carried out shows that twelve (12) States and four (4) river basins, which are: Niger, Upper Benue, Lower Benue, Sokoto, Cross River, Chad and the Hadeija-Jumare have over 278 unexploited SHP sites with a potential of 734.3MW and SHP potentials exist in all part of the country with an estimate of 3,500MW (Adewuyi, 2005; Sambo, 2007). Also, a private company called Nigerian Electricity Supply Company (NESCO) and the government have installed eight (8) SHP stations with aggregate capacity of 37MW in Nigeria. Most of these stations are found around Jos, with 2MW station at the Kwall Falls on the River Kaduna and 8MW station at Kurra Falls are located even though the power station were developed more than 75 years ago. Fig 9: shows a typical layout of a small hydropower plant

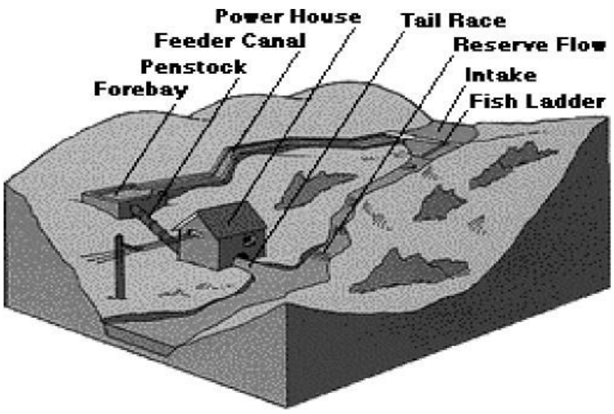

Fig 9: Typical Layout of a Small Hydropower Plant. Source: Hydro Power
www.fae.sk/Dieret/Hydro/hydro.html

Solar Energy

Nigeria is within a high sunshine belt with enormous solar energy potentials. Electricity generated from solar energy is from photovoltaic materials (cells or modules) which convert sunlight directly into electricity. In Nigeria, solar photovoltaic technologies are used for small-scale power supply to the remote villages, water pumping (52%), village electrification (39%), rural clinic and schools power supply, vaccine refrigeration, traffic lighting and lighting of road signs (9%). The current total of solar photovoltaic installations is 1MW (Sambo, 2007).

ISSN 2277 – 5528
Impact Factor- 3.145

Wind Energy

The wind energy is converted into electricity by using wind turbines, as the wind blows the propeller around it rotates the generator to produce electricity and the average wind speed of 14mph is required to convert wind energy into electricity. The technologies on wind energy have been tried over the years in the northern parts of the country, mainly for water pumping from open wells in Sokoto, Kano, Katsina, Bauchi and Plateau States. The functional wind electricity system in the country is 5 kW wind electricity used for village electrification in Sayyan Gidan Gada, in Sokoto State (Sambo, 2007).

VI. CHALLENGES OF RENEWABLE ENERGY GENERATION IN NIGERIA AND ITS POSSIBLE SOLUTION

The renewable energies in the country have not been tapped or developed due to the following reasons:

- The technical expertise to develop, and manage the renewable energy technologies are often sourced from outside the country.
- The materials for the manufacturing of renewable electricity system components are not available in the country. Supply systems and components are imported
- Financial encouragement is not available to increase the development of the supply and demand sides of the renewable energy electricity market
- There is general lack of awareness about the benefits from renewable energy electricity
- Renewable energy electricity systems have high initial cost. This has limited the penetration of the system into the electricity market

The possible solutions are as follow:

- Renewable Energy Fund should be available to serve as the instrument for the provision of financial incentives to local manufacturers, suppliers and users of RE electricity,
- Adequate fiscal incentives to local suppliers and manufacturers of renewable energy electricity system components
- Awareness about renewable energy should well spread and known to all

Impacts of Electricity Generators in Nigeria

Economic Impact

- Hydro plants have lower operating and maintenance costs since no fuel is required
- Hydroelectric plants have longer economic lives which range from than 50 to 100 years after its construction
- Serves as recreational and tourist to people e.g the Kainji lake.
- Its stimulate developments anywhere the plant is located
- It is long time payback period operation speed
- Thermal power plant have lower installation costs and its occupy a smaller area of land compare to hydro station
- Gas turbine plant have a high operation concerning speed

Environmental Impact

- Emission of harmful gases to the environment during the construction
- Pollution during exploitation of natural gas
- Alteration of river, landscape and ecosystem
- Displacement of people from their ancestral and cultural settlement/farmland
- Noise pollution

VII. DISCUSSION

Nigeria started its electricity generation in the year 1896 and still remains unable to generate enough electricity to meet it present need for industrial development. It may be more accurate to suggest that the NESCO hydroplant should be classified as the first hydropower plant in Nigeria since commences operation in the year 1929 as electric utility company with the construction of hydropower station in Kurra near Jos with the total electricity generation of 48MW . This contrast sharply with the other hydroelectric power plants, Kainji and Jebba which after 42years and 23years still have an installed capacity of 760MW and 540MW respectively.

ISSN 2277 – 5528
Impact Factor- 3.145

It is also safe to suggest that electricity reform act passed into law in 2005 a success. Though there has not being significant improvement in the country's generating capacity and the target of the reform is not a success since fewer IPPs came in and invested due to the fear of government inconsistent policies which may not favour them did not encourage them to improve on their output.

However 2010 highlighted notable successes in the reforms due to minimal government participation in generation and distribution as well as the introduction of bills to favour investors in the energy sector irrespective of the prevailing government. This brought about changes in the electricity sector in the country..

Nigeria as a country is blessed with different kinds of natural resources which has been evenly distributed throughout the country; each zones of the four cardinal point of the country have unique natural resources. For example, the north-eastern part of the country is dominated with high wind energy and solar radiation/intensity, the south-western region is characterised by a larger percentage of biomass production, natural gas, deltaic environment which can be dammed for hydropower plant as well as open oceans which can be utilised for tidal and wave energy and in the south-eastern part of the country where a huge amount of coal deposit is housed which is not been used or utilized for electricity generation. The question is apart from the thermal and hydro power plant, what of kind of generator can be used in order to increase the country electricity generating capacity. This investigation therefore recommends the use of other generators like solar photovoltaic cells, tidal barrage, coal thermal plant, and wind turbine which could be installed in the region only that have the potential for the resources.

VIII. CONCLUSION

In order to improve the socioeconomic wellbeing of Nigerians, there is need to increase the country's generation capacity and high priority should be given to low cost of power to enable an average citizen opportunity to use electricity and of all the natural resources. Renewable energy is considered as the solution facing the country especially the rural areas while there is also the need increase the generating capacity as to meet demand. In order to achieve all this, different kinds of generation should be invested in and the transmission lines should be upgraded to transmit energies from other renewable energies.

REFERENCES

1. *Adewuyi, O.T. 2005. Small Hydro Schemes: Taking Nigeria's Energy Generation to the Next Level. Inaugural IEEE PES Conference and Exposition in Africa. Pg 112-119. Durban: South Africa. [Online]. Available from: http://www.Libsou.com/pdf . (Accessed 2 November 2014)*
2. *Adetunji M and Shuiaibu, T. 2007. The demand for residential electricity in Nigeria: A bound testing approach. [Online]. Available from: http://www/africametrics.org/documents. (Accessed 15 January 2015)*
3. *Bureau of Public Enterprises BPE (2011). 4852MW Electric Power Investors' forum [Online]. Available from http://www.nigeriaelectricityprivatisation.com/wpcontent/uploads/downloads/2011/02/Power_Generation_Outlook_Investor_Forum_Presentation_BPE.pdf. (Accessed 2 November 2014)*
4. *DIERET. 2004. Hydro Power. [Online]. Available from: http://www.inforse.org/europe/dieret/Hydro/hydro.html. (Accessed 12 January 2015)*
5. *Energy Commission of Nigeria (ECN). 2007. Assessment of energy options and strategies for Nigeria: Energy demand, supply and environmental analysis for sustainable energy development (2000-2030). Abuja: Nigeria. [Online]. Available from: http://iaee.org/en/publications/newsletterdl.aspx (Accessed 15 January 2014)*
6. *Federal Ministry of Power and Steel (FMPS). 2006. Federal government of Nigeria: Renewable electricity policy guideline. Abuja: Nigeria. [Online]. Available from: http://www.iceednigeria.org. (Accessed on 17 December 2014)*
7. *Ibitoye F.I and Adenikinju. 2006. Future demand for electricity in Nigeria. Applied Energy 84: (2007): pp.492-504. [Online]. Available from: www.elsevier.com/locate/apenergy*
8. *International Atomic Energy Agency (IAEA), 2003. Model for energy supply strategy alternatives and their general environmental impacts. [Online]. Available from www.iaea.org/OurWork/ST/NE/Pess/.../oil+np_toth+rogner0106.pdf. (Accessed 16 November 2014).*
9. *International Energy Agency (IEA). 2005. Energy statistics and balances of non-OECD countries. 2005 Ed. IEA: Paris.*

ISSN 2277 – 5528
Impact Factor- 3.145

10. *National Electric Power Authority (NEPA). 2004. Power reform and power-generation plans in the public and private sectors. NEPA publication: Abuja, Nigeria.*
11. *Nigerian Electricity Regulatory Commission (NREC). 2009. Electricity generation data sheet. NREC: Abuja. [Online]. Available from http://www.nercng.org.*
12. *Power Holding Company of Nigeria. 2007. Electricity generation capacity report. PHCN publication: Abuja: Nigeria.*
13. *Renewable Energy Masterplan. 2006. National Energy Masterplan Report. Abuja: Nigeria.*
14. *Sambo, A.S. 2007. Alternative generation and renewable energy. Energy Commission of Nigeria: Abuja: Nigeria. [Online]. Available from: http://www.energy.gov.ng/index.php?option=com_docman&task=cat. (Accessed 16 November 2014).*
15. *Sambo, A.S. 2008. Making Electricity Supply with Demand in Nigeria. International Association for Energy Economics, Fourth Quarter 32-36.*
16. *Salihi, A. 2013. Hydropower development at Tiga and Challawa Gorge dams, Kano State, Nigeria. [Online]. Available from: http://www.inshp.org/THE%205th%20HYDRO%20POWER%20FOR%20TODAY%20CONFERENCE/Presentations/Nigeria/Hydropower%20Development%20At%20 (Accessed 17 November 2014)*