Energy Sector and Sustainable Development in Nigeria*

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1. Introduction

- I am indeed honoured to be invited by the Commandant, National Defence College of Nigeria, Rear Admiral N. P. Aghalor to deliver this lecture on the Energy sector and sustainable Development in Nigeria to the Course 23 participants of the College. I gather that participants to this Course are mostly of Colonels and their equivalents drawn from the Nigerian Armed Forces, Nigerian Police, Paramilitary Services, and Strategic Federal Ministries as well as sister African Armed Forces. Participants are therefore from the cream of the society. May I, on behalf of Energy Commission of Nigeria congratulate all course 23 participates and wish them well.
- Energy is technically defined as the ability to do work. It exists in various forms such as
  chemical, magnetic, electromagnetic, thermal, kinetic, mechanical, potential, elect rical etc; and that it can be transformed from one form to another but cannot be created nor destroyed.
- The Oxford Advanced Learner Dictionary defines development as the gradual **growth** of something so that it becomes more **advance**, **stronger**, e.t.c.

1. Introduction Cont'd….

- **Energy and Development**
  - Energy has been essential for human development. Some school of thought imprecisely expressed the relation between energy and development as (Chawncey Starr, Ed, 1980):-

    Energy = Progress = Civilization
  - Other school of thought are a bit more precise in expressing the relationship through the following expression (ECOWAS, 1982):-

$$L = R \times (E/P) \times I_{ng}$$

where

L = standard of living

R = raw material consumed

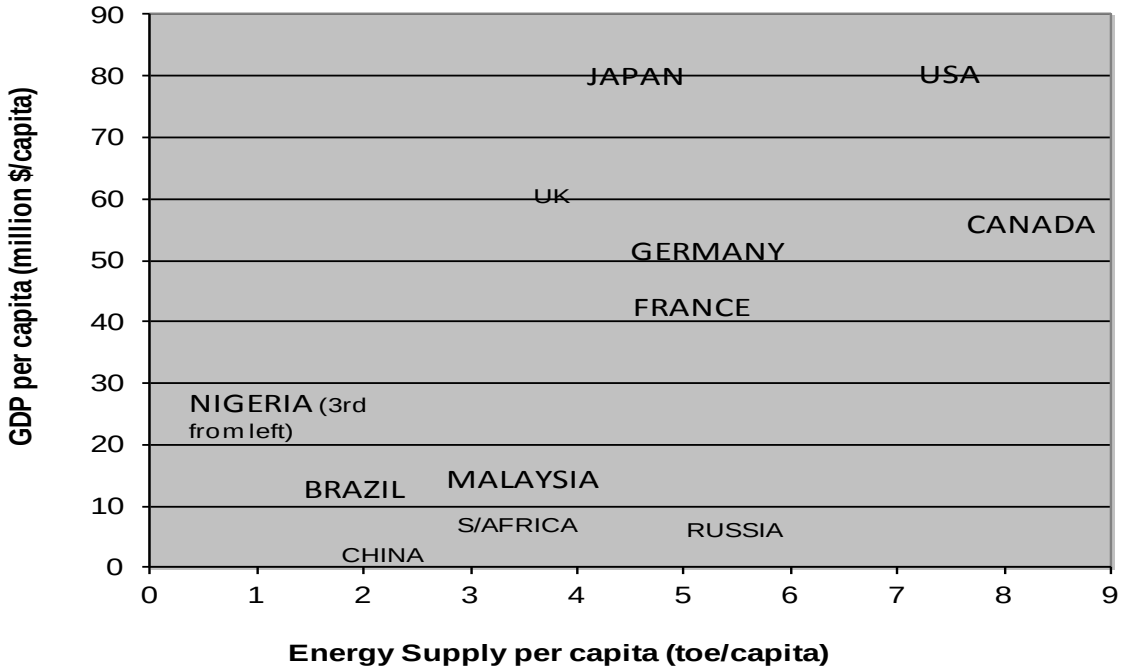
E = energy consumed

I_{ng} = ingenuity applied (technology, political and economics)

P = population

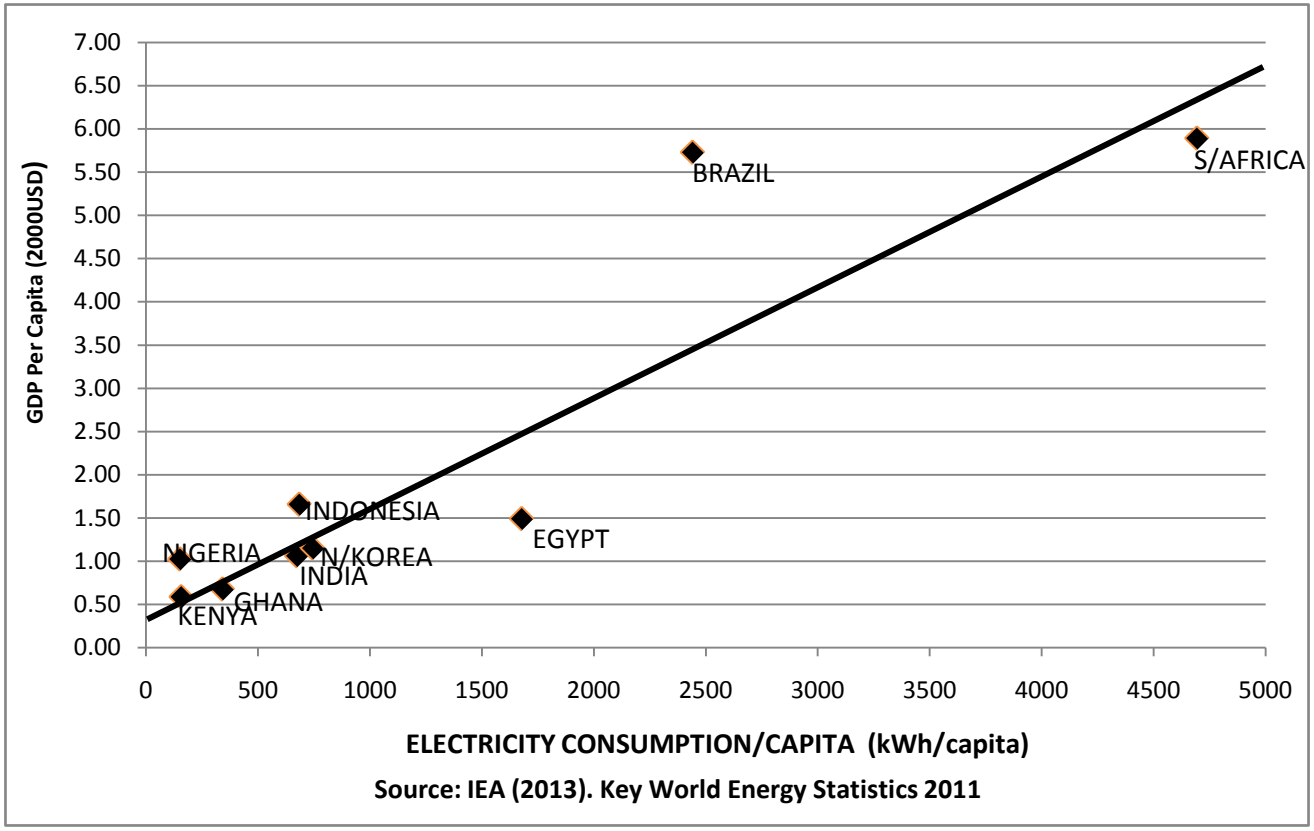
1. Introduction Cont'd….

– The relationship between economic development of nations, which is imperative to human development, and energy can be graphically illustrated as below:-



Graphical representation of the relationship between Energy and the Economy (IEA, 2010)

1. Introduction Cont'd….



Effect of Electrical Energy Consumption on Economic Development of Nations.

1. Introduction Cont'd….

- **History of Energy Utilization**:
  - Let there be light and there was light (Genesis 1:3 KJV). The sun is therefore the early source of energy, generated from thermonuclear process.
  - Early people relied, and we still do rely, mainly on energy from the sun transformed into chemical energy stored in food that produce energy of working muscles
  - Human intellect, however, unlocked and did overcome physical limit imposed on muscle power by using tools and harnessing the energies outside its own bodies. These included the use of firewood for heating and cooking; while use of muscles of domesticated animals became exploited for human development
  - Then humans began to transform water energy into mechanical energy through the use of water wheels. Similarly, wind was utilized in winnowing and mechanical energy production.

1. Introduction Cont'd….

- Coal for heat energy generation and steam engines for mechanical energy production were discovered in the 18th century. Steam engines, therefore joined water wheels in the production of mechanical energy for enhanced economic activities; though steam engines overcome water wheels because of its geographic flexibilities
- In the mid 18th century, Benjamin Franklin, an English Scientist, proved the relationship between lightning and electricity and invented lightning rod; while in the early 19th century Michael Faraday discovered electric current in a copper wire moving in a magnetic field, which led to the electric generator and motor. The electric bulb was invented in the mid 19th century by British Physicist, Joseph Swan
- In the same mid 19th century, the first crude oil well drilled to produce oil as fuel occurred in Pennsylvania, USA; after oil was discovered in the US when digging shallow water wells, but was considered a contaminant instead of useful fuel.

1. Introduction Cont'd….

- The idea of transmission of electricity via cables was borne by Thomas Edison an American in the late 19th Century using DC; while Nicola Tesla, a Serbian who worked with Thomas Edison developed AC
- The discovery of nuclear radiation that led to the use of atomic power was also done in the 19th century, primarily, by Marie Curie
- By the 20th century, hydro, coal, oil and the atom became the major commercial source of energy worldwide, popularly referred to as conventional sources of energy; while firewood continues to be a major source of domestic energy in the developing world, particularly in the sub-Saharan Africa.

- **Sustainable Development**:
  - the most quoted definition of sustainable development is that by Brundland Commission Report (Ref 5) which defines sustainable development as "***development that meets the needs of the present without compromising the ability of future generations to meet their own needs***."
  - Sustainable development is traditionally viewed from three perspectives of environmental, economic and socio-political sustainability. However, some school of thought view it from the perspectives of economic, ecological, political, and cultural sustainability

1. Introduction Cont'd….

- In any case, sustainable development is about finding better ways of doing things both for the present and future. That is the philosophy behind President Goodluck Ebele Jonathan's Transformation Agenda. However, as was earlier mentioned, energy is pertinent to development; and for development to be sustainable, it must be driven by sustainable energy sources. It is also clear that the sequence of energy utilization for human development started with the sun, human muscle, firewood and animal muscles, water and wind, coal, oil and electricity. It may be noted that almost all energy forms of energy may be transformed into electricity.

- Classification of Energy Sources
  - **Fossil Sources**: these are hydrocarbon energy sources formed over hundred of millions of years from organic matter and under the earth's crust under high temperature and pressure e.g. petroleum and coal. Fossil sources are depleting energy sources, while their consumption upsets the natural balance of carbon dioxide in the atmosphere, which causes climate change with adverse consequences to humanity. They are non sustainable sources of energy.

1. Introduction Cont'd….

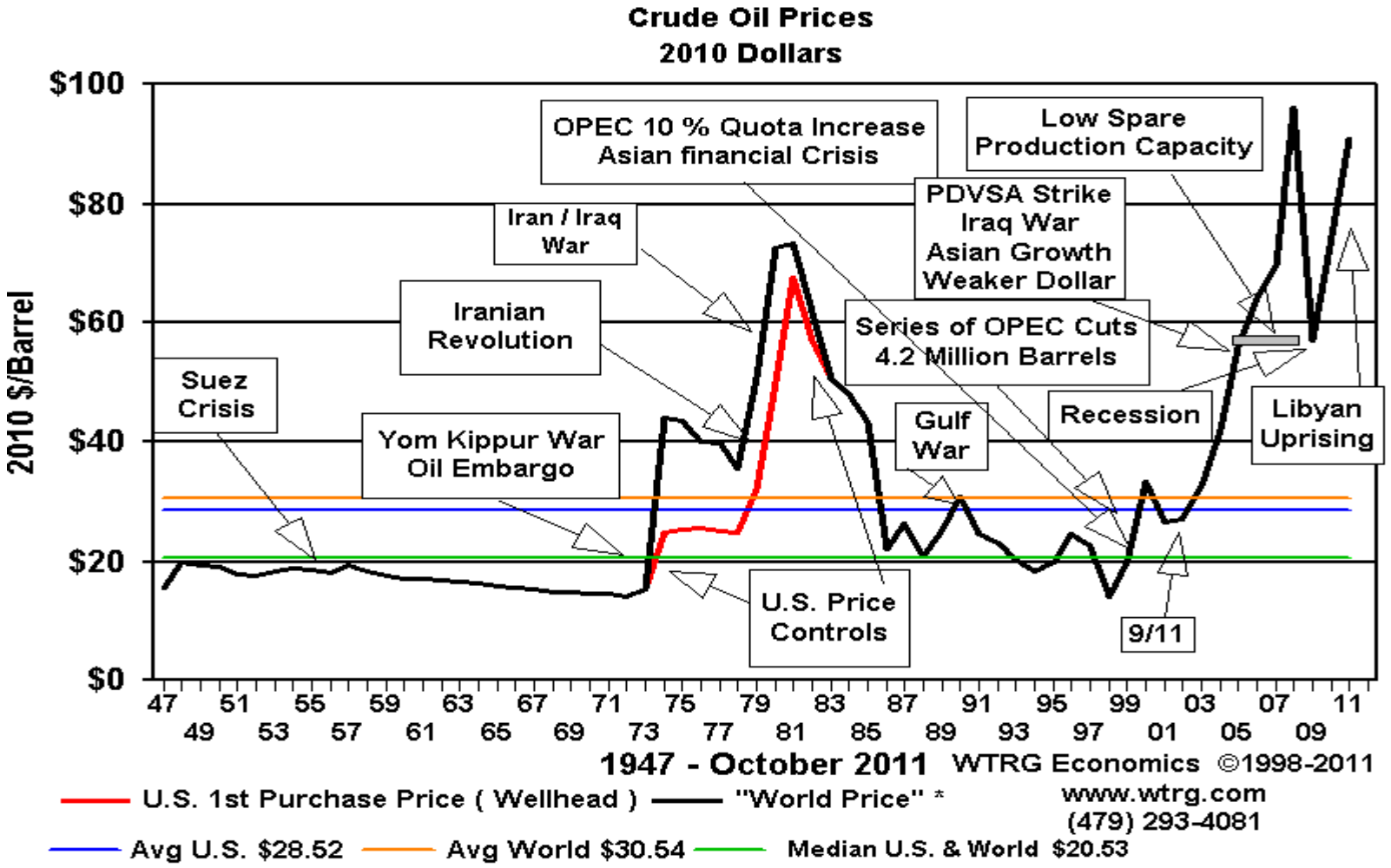
- **Renewable Energy Source**: this is an energy source, which can replenish itself within a relatively short time and through natural process e.g. solar, wind, hydropower, geothermal, biomass, etc. They are relatively non depleting and their consumption has little negative effect on our environment and therefore the preferred source of energy for driving sustainable development.
- **Nuclear Energy Source**: this is an energy source from the atom, from where radiation is emitted through mainly atomic fission & fusion. It is low carbon energy source. However, nuclear radiation safety poses a heath and social concern worldwide.

- **Final Energies Relevant for Driving Economic Activities**
  - **Electricity**: this can be generated from all sources of energy
  - **Fuels**: this is produced from fossil and renewable energy source (mainly Biomass)
  - **Process Heat**: this is produced from fossil fuels, nuclear energy source, electricity and renewable energy sources

1. Introduction Cont'd….

- No wonder, the National Energy Policy document for Nigeria does indicate that "*Energy has a major impact on every aspects of our socio-economic life. It plays a vital role in the economic, social and political development of our nation. Inadequate supply of energy restricts socio-economic activities, limits economic growth and adversely affects the quality of life. Improvements in standards of living are manifested in increased food production, increased industrial output, the provision of efficient transportation, adequate shelter, healthcare and other human services. These will require increased energy consumption. Thus, our future energy requirements will continue to grow with increased in living standards, industrialization and a host of other socio-economic factors.*"
- The National Energy Policy also identified energy not only a commodity for trade and income generation but also as an instrument for foreign policy in the promotion of international cooperation and development.

1. Introduction Cont'd….



Source: http://www.wtrg.com/prices.htm

2. Energy Resources & Infrastructure in Nigeria

a) Fossil Energy Resources and Nuclear Energy Sources

S/N	Resources	Reserves	Production (2012)	Domestic Utilization (2012)
1	Crude Oil	37.2billion barrels	0.853billion barrels	0.164billion barrels
2	Natural Gas	187 Tscf	2.58Tscf	77% : Utilized 23% : flared
3	Coal	2.7 billion tonnes	0	Negligible
4	Tar Sands	31 billion barrels of oil equivalent	0	18.25 million barrels
5	Nuclear	Yet to be quantified	0	30kW experimental nuclear reactor

Source: NNPC/ECN

2. Energy Resources & Infrastructure in Nigeria

b) Renewable Energy Resources

S/N	Resource		Reserve	Utilization Level
1	Large hydro power		11,250MW	1,900MW
2	Small Hydro power		3,500MW	64.2MW
3	Solar Energy		4.0 kWh/m^2/day 6.5kWh/m^2/day	15MW solar PV stand-alone No solar thermal electricity
4	Wind		2-4m/s at 10m height	2x2.5KW electricity generator; 10MW wind farm in Katsina
5	Biomass	Fuel wood	11 million hectares of forest and woodlands	43.4 million tonnes of firewood/yr
		Municipal waste	- 18.3 million tonnes in 2005* & about 30 million tonnes/yr now	-
		Animal waste	- 243 million assorted animals in 2001	-
		Energy Crops and agric waste	- 72 million hectares of Agricultural land	28.2 million hectares of Arable land only 8.5% is cultivated

Source: Renewable Energy Master Plan (REMP)

3. Energy Supply: Where are we and from where?

Nigeria's Energy Supply and The Economy

S/N	ITEMS	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1.	Electricity generation (billion kWh)	22.03	23.9	24.22 (503)* (10,695)**	23.8	23.3	21.27 (562)* (18,603)**	20.8	25.02	27.7 (619)* (20,407)**	29.6
2,	Energy Consumption per Capita (kgoe/Capita)	151.3	125.5	132.6 (680)* (1,780)**	87.1	81.4	80.8 (670)* (1,830)**	83.1	77.8	73.6 (670)* (1880)**	65.7
3.	Electricity Consumption/capita (kWh/Capita)	174.6	176.4	181.4 (563)* (2596)**	167.6	161.2	142.9 (571)* (2782)**	135.2	157.1	165 (592)* (2933)**	175.9
4.	GDP/Capita (US$/Capita)	620.7	658.0	826.3 (2314)* (8,492)**	1030.3	1223.5	1286.3 (2540)* (9550)**	1,106.8	1440.7	1470.6 (1281)* (7520)**	1513.4
5.	Energy Intensity (kgoe/ US$)	0.244	0,191	0.161 (0.294)* (0.210)**	0.085	0.067	0.063 (0.264)* (0.192)**	0.075	0.054	0.050 (0.550)* (0.250)**	0.043
6.	GDP Growth Rate (%)	9.6	6.6	6.5	6.0	6.5	6.0	7.0	8.0	7.4	6.6

Sources: CBN (2005-2012), NCC, Osogbo (2009 -2012),
****Africa Average - IEA (2007, 2010, 2013)***
*****World Average - IEA (2007,2010, 2013)***

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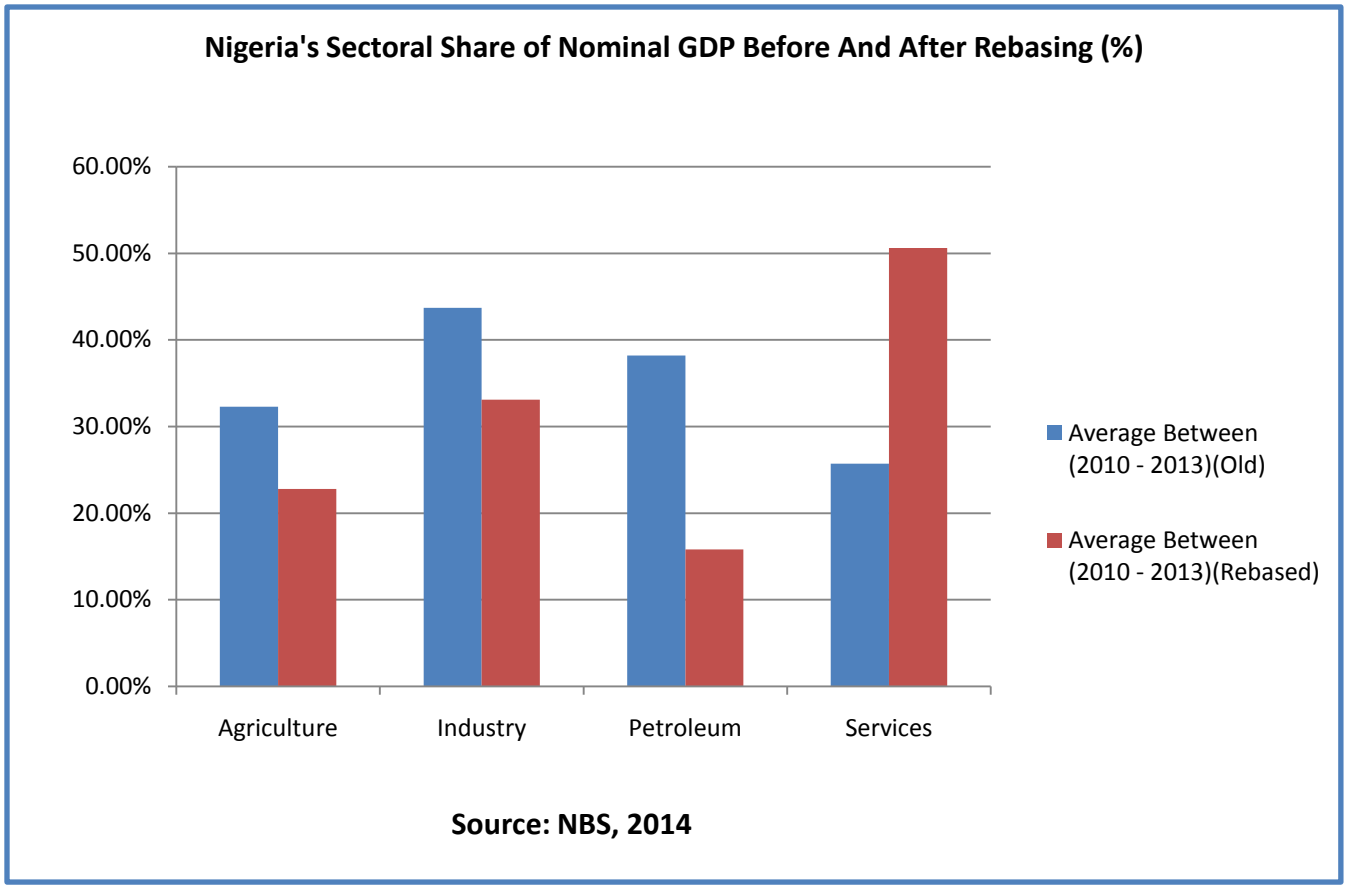
3. Energy Supply: Where are we and from where? Cont'd

Nigeria's Energy Supply and The Economy Cont'd…



3. Energy Supply: Where are we and from where? Cont'd

- The Nigerian energy scene began, when in 1914, the Northern and Southern protectorates under the Colonial British Government were amalgamated to form the present state of Nigeria situated between latitudes 4^{o} N and 14^{o} N and longitudes 3^{o} E and 14^{o} E

a) Petroleum (Oil and Gas)

– In 1914, the Minerals Oils ordinance of Nigeria was made by the Colonial Government, which ensured that all minerals oil under Nigeria soil a legal property of the Crown. Licenses for oil production were restricted to British Companies and individuals. In 1938, Shell D'Arcy company, a company jointly owned by Shell and British Petroleum (BP) was given exclusive exploration and production regions in Nigeria. In 1955 Shell D'Arcy's monopoly was reduced and concession area was granted to Mobil, an American Oil Company.

3. Energy Supply: Where are we and from where? Cont'd

- In 1956, and in Olaibiri, about 90km west of Port Harcourt and now present Bayelsa State, crude oil in commercial quantity was first found in Nigeria by Shell D'ARCY. The first export of crude oil was in 1958 with export of 5,100 barrels per day (BPD). The 1959 Petroleum profit tax legislation made sharing of proceeds from oil on a 50:50 basis between the host country and foreign oil companies.
- It may be recalled that Nigeria got independence in 1960, the same year Organization of Petroleum Exporting Countries (OPEC) was found in Badhdag, Iraq. OPEC's objective was to check concessioners from lowering prices, which they always specified or posted and to take control of their oil resources.
- By 1961 oil production stood at 46,000 bpd, while natural gas produced was about 11,500 standard cubic feet (SCF) per year.
- By 1962, Shell's arena of concession was further reduced to more promising areas, while more actors like Elf, Agip etc came into the scene in line with the 1962 Mineral Oils Act, which repealed the provision of the 1914 Act reserving concessions for oil exploration to only British subjects.

3. Energy Supply: Where are we and from where? Cont'd

- In 1964, Nigeria attended the first OPEC meeting as an observer. In 1965, the Bonny Island Export facility terminal was completed; and oil and natural gas production was about 272,000 bpd and 105,500 SCF/year, respectively. In the same year, the Oil Pipelines Act of 1965 and the regulations made there under as well as the Hydro Carbon Refineries Act and the regulations there under were made. These enabled the establishment of the first refinery in Nigeria built at Alesa Eleme, Port Harcourt with a name plate capacity of 35,000 bpd, considered then sufficient to meet domestic needs. It was build and operated by Shell. The population of Nigeria was then about 58.7 million. This was later acquired by Government (NNPC). It may be noted that hitherto all Petroleum products consumed in the economy were all imported, and by the international oil companies (IOCs).
- In 1966, the first coup d'etat occurred, which plunged the country into a civil war that lasted up to 1970. Within this period crude oil production dropped from 418,000 bpd in 1966, to 142,000 bpd in 1968; and then rose to 1,084,500bpd in 1970.

3. Energy Supply: Where are we and from where? Cont'd

- In 1968, the Nigerian Company Decree compelled all companies operating in Nigeria to incorporate Nigerian entities; while the 1969 Petroleum decree and the Petroleum (Drilling and Production) regulation provided a comprehensive framework for administering the activities of the oil companies. These decrees provided Nigeria legal framework for participation in the oil companies, which commenced with 35% and later grew to 50%.
- It may be noted that Petroleum matters had been handled by the Hydrocarbon section of the Ministry of Lagos Affairs in the earlier fifties. It was the first statutory agency set up to supervise and regulate the Petroleum industry in Nigeria, which reported to the Governor General. The section was upgraded to Petroleum Division within the then Ministry of Mines and Power. The division, in 1970, became the Department of Petroleum Resources (DPR).
- In 1971, Nigeria joined OPEC, and in the same year the Nigerian National Oil Corporation (NNOC) was created to engage in commercial activities in an attempt to realize the indigenization of the oil industry in response to call by OPEC for member states to participate actively in their oil industry, while DPR continued to perform the supervisory and control duties in the oil industry. This direct participation by NNOC was done through joint ventures (JVS). In 1974, Nigeria's participation in the oil companies had reached 55%.

3. Energy Supply: Where are we and from where? Cont'd

- The DPR was in 1975 constituted into the Ministry of Petroleum Resources. In the same year 1975, the PPT reached 85% and remained there since.
- In 1977, the MPR and NNOC were merged to form the Nigerian National Petroleum Corporation (NNPC), in a bid to optimize the utilization of the then scarce indigenous manpower in the public sector of the oil industry. The same instrument that created NNPC also established the Petroleum Inspectorate, which served as the regulator of the industry, which however, reported to the Minister of Petroleum. In 1978, Government began to build local refineries and distribution networks.
- In 1979 Nigeria participation in upstream oil companies had reached 60%.
- In 1985, a new Ministry of Petroleum Resources was again created, while the Petroleum Inspectorate remained in NNPC and as the regulator of the industry.
- With the commercialization of NNPC in 1988 into twelve (12) strategic business units covering the entire spectrum of oil industry operations of exploration and production, gas development, refining, distribution, petrochemicals, engineering and commercial investments; the petroleum inspectorate was excised and merged with Ministry of Petroleum Resources but maintained its regulatory functions.

3. Energy Supply: Where are we and from where? Cont'd

- By 1989, four (4) government owned and managed oil refineries with a total installed capacity of 445,000 bpd were installed, to meet domestic needs, when population was about 83.8 million. However, Since 1989 to date no new refinery has been added to meet the growing demand in Petroleum Product for automobile fuel, power generation, heating fuel, lubricants etc for a population of about 170 million now and growing at 3.2% annually. Secondly, the capacity utilization of these refineries have been dropping to unacceptable levels. For instance, the combined average refining capacity utilization for year 2012 was 21% and 26% in 2013. This has led to massive importation of products to meet domestic needs.
- Also, in 1989 the Nigeria Lignified Natural Gas (NLNG) Bonny with Government take was incorporated; and ten (10) years later, NLNG commenced production for exports. More NLNG plants have since come on-stream
- Nigeria supplies natural gas to other West African countries through the West African Gas Pipeline (WAGP) conceived in 1982 and completed in 2006 with a capacity of 5bcm (185bscf) of natural gas per year (about 500 mmscf/day).

3. Energy Supply: Where are we and from where? Cont'd

Historical Evolution of Refineries in Nigeria with their Installed Capacity

Refinery	Year Commissioned	Capacity (Barrels/Day)								
		1965	**1971**	**1978**	**1980**	**1987**	**1988**	**1989**	**1998**	**2014**
P/H Refinery I	1965	35,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
P/H Refinery II	1989	-	-	-	-		-	150,000	150,000	150,000
Warri Refinery	1978	-	-	100,000	100,000	125,000	125,000	125,000	125,000	125,000
Kaduna Refinery	1980	-	-	-	110,000	110,000	110,000	110,000	110,000	110,000
Total		35,000	60,000	160,000	270,000	295,000	295,000	445,000	445,000	445,000

Source: NNPC

3. Energy Supply: Where are we and from where? Cont'd

- The challenges and inefficiencies in the operation of the joint ventures and the unsatisfactorily performance of the downstream public enterprises as well as complexity on the management of the NNPC, coupled with too many laws in the oil and gas industry necessitated calls for structural reforms in the Nigeria Petroleum industry to position it for greater benefits to the Nation in line with international best practices.
- Thus in 2000, Government incorporated the Oil and Gas sector Reform Implementation Committee (OGIC) to carry out far reaching reforms in the Petroleum industry. To evolve new National Oil and Gas Policy, which will ensure separation and clarity of roles, infuse strict commercial orientation in all relevant sections of the industry.

3. Energy Supply: Where are we and from where? Cont'd

- In 2003, the Petroleum Product Pricing and Regulation Agency (PPPRA) was established to regulate the downstream oil sector.
- In 2006, MPR and Ministry of Power were merged to form the Ministry of Energy. A year later, the Ministry of Energy was reverted back into MPR and Ministry of Power and remains so to this day, with DPR still under the MPR.
- In 2007, the Government inaugurated another 2nd OGIC committee to work on the National Oil and Gas policy produced by the 1st Committee with the view to bringing out new institutional framework for the industry. This produced Lukman Report of 2008, which went through another review before it was forwarded in 2012 to the National Assembly as the popular Petroleum Industry Bill (PIB).

3. Energy Supply: Where are we and from where? Cont'd

- In 2008, Nigerian Gas Master Plan was approved with the objective of transiting the Nigerian oil industry into an integrated oil and gas industry through:
  - Domestic gas supply obligations
  - Cost recovery gas pricing framework
  - Gas infrastructure blueprint
- In 2010, the Gas Aggregation Company of Nigeria (GACN) owned by the IOCs and NNPC was formed as a vehicle for the implementation of Nigerian Gas Master Plan framework
- In 2010 also, the Nigerian Oil and Gas Industry Content Development Act was made with the Primary objective of enhancing the level of participation of Nigerians and Nigerian Companies in the country's Petroleum Industry.

3. Energy Supply: Where are we and from where? Cont'd

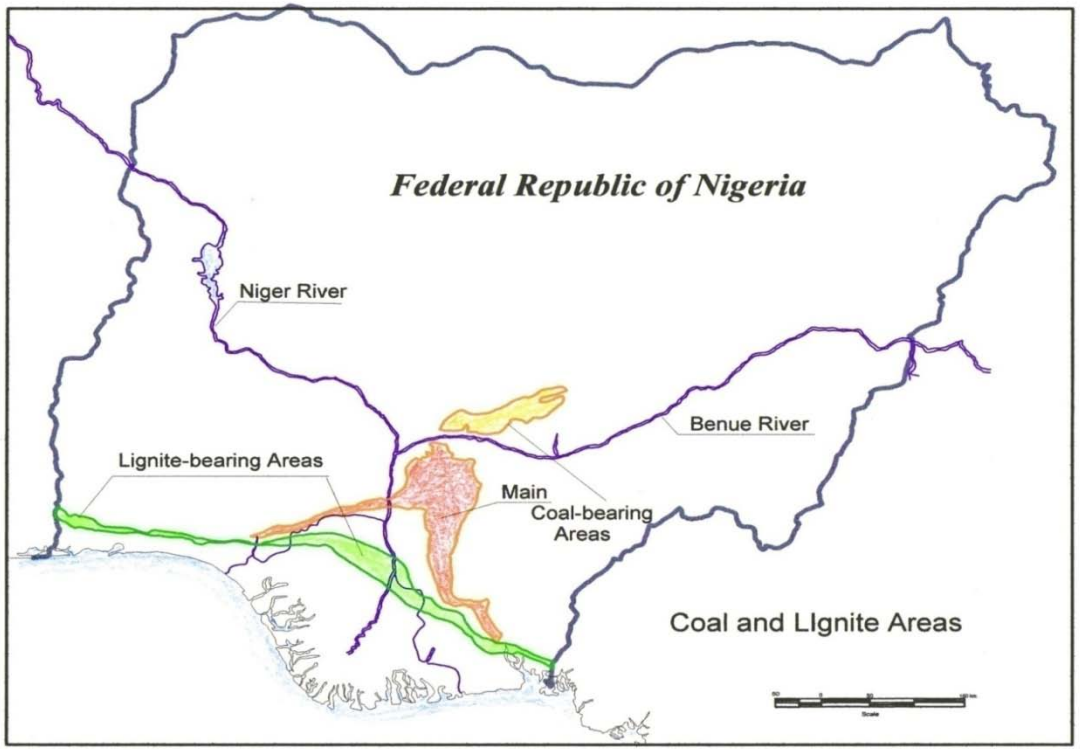
b) Coal/Lignite, Tar Sands/Bitumen and Uranium (Solid Minerals)

i. Coal/Lignite:

– Organized mining began in 1903 when the Mineral Survey of the Northern protectorates was created by the British Colonial Government. A year later, the mineral survey of the Southern protectorate was founded. Coal was first discovered in Enugu in 1909. Its production began as early as 1916, with an annual production output of 24,511 tonnes. In 1950, the Nigerian Coal Corporation (NCC) was established by Government and charged with the responsibility of exploring, developing and exploiting the country's coal and lignite resources. The production peaked in 1959 with an output of 905,397 tonnes per annum. Production of coal seized during the 1966-1970 civil hostilities. After the hostilities, production peaked again, in 1972, at 323,001 tonnes per annum; there after, it began to decline. Between 1988 and 1998, coal production generally continued to decline from an output of 82,490 tonnes to 21,940 tonnes per annum.

3. Energy Supply: Where are we and from where? Cont'd

– The decline, in the 1970s in coal production was mainly due to the loss of its traditional market to newly found and more competitive fuel substitutes, e.g. diesel for locomotive engines and high pour fuel oil (HPFO) and natural gas for power generation. The contribution of coal in the nation's energy mix declined from 70% in the 60s to insignificant value now. However surface coal mining is now being carried out in Akko LGA of Gombe state where reserves of up to 20 million tonnes is estimated. Production at the site by Ashaka Cement Company is about 300 tonnes per day; and is expected to double so as to replace 90% of its total heat requirement, hitherto supply by fuel oil (black oil).



(MODIFIED AFTER BEHRE DOLBEAR, 2005)
Source: Nigerian Coal Corporation (2009)

Coal & Lignite Deposits of Nigeria

3. Energy Supply: Where are we and from where? Cont'd

ii. Tar Sands/Bitumen

- Focused exploration of Bitumen began in 1905. Tar Sands deposits are found in Osun, Ondo and Edo States axis. Tar sands production is yet to commence.

iii. Nuclear Energy

- The Nigeria Uranium Mining Company (NUMCO) was established as a public private partnership with Total Compagnie Miniere of France for the exploration and mining of uranium in Nigeria. In 1989 Total pulled out and in 1993, government transferred Numco's responsibilities to the Nigerian Geological Survey. Some studies have found traces of nuclear minerals in Cross Rivers state, North-West and North-East of the country.
- Nuclear implementation and regulatory institutions, Nigeria Atomic Energy Commission (NAEC) and Nuclear Regulatory Authority (NNRA) were established in 1976 and 1995 through their enabling Acts, respectively. However, NNRA commenced operation in 2001, while NAEC commenced operation in 2006.

3. Energy Supply: Where are we and from where? Cont'd

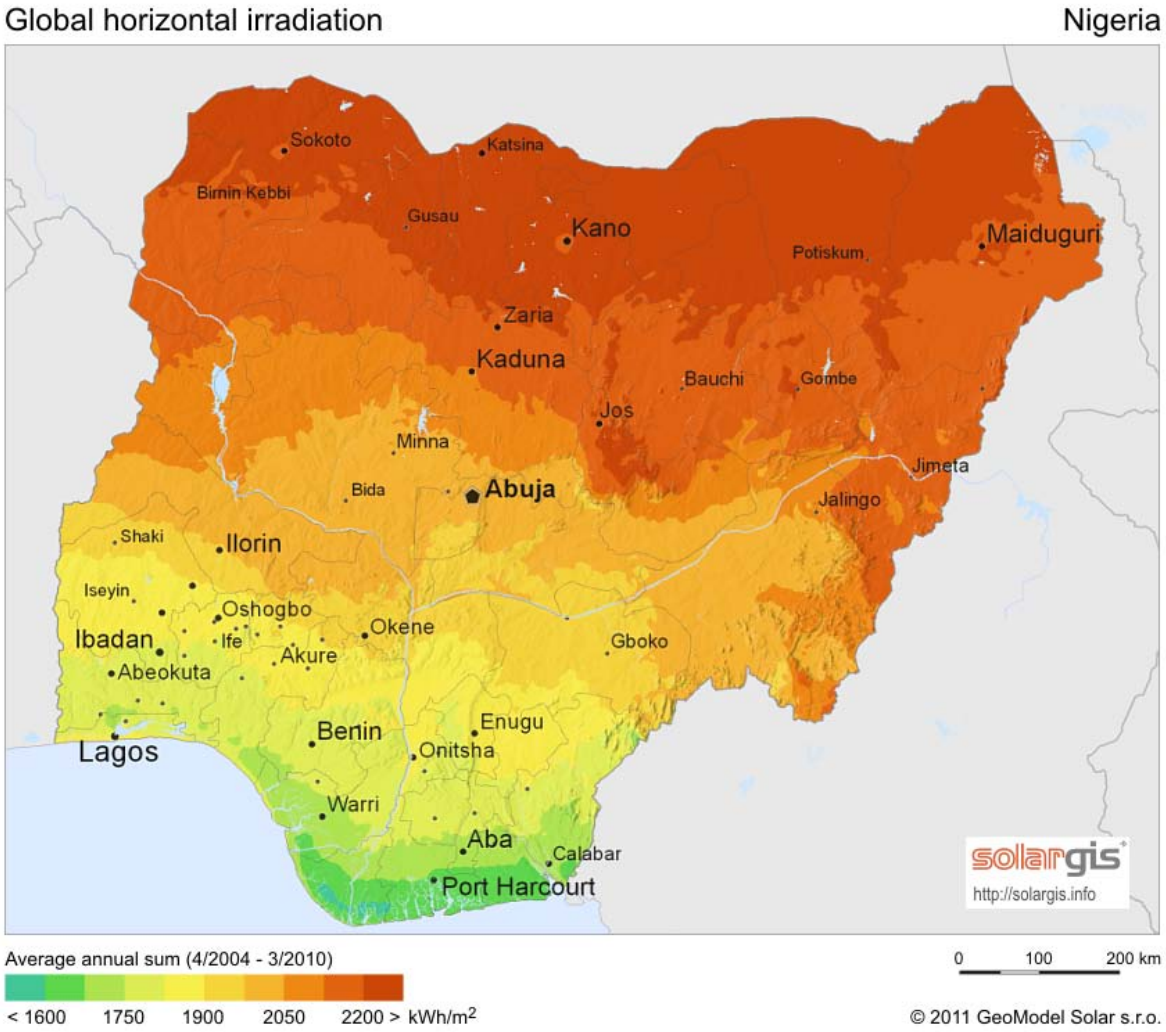
- In 2007, FGN approved the National Nuclear Power Roadmap for the National Power Programme (NPP) to be implemented within 10 – 12 years.
- The Roadmap anticipate 1,000MW by 2020 and 4,000MW by 2030 through Built Own Operate and Transfer (BOOT) with Russian Federation.
- Preliminary sites in Kogi and Akwa Ibom States have been selected.
- The Nuclear Energy Research & Training Centres in Zaria and Ile-Ife were established by the NAEC Act of 1976 and started operations in 1979. With the re-activation of NAEC in 2006, two new nuclear research centres have been established at the Universities of Maiduguri and Portharcourt. It should be noted that a 30kW nuclear research reactor is in CERT, Zaria. Other supporting institutions for the NPP are SHETSCO, Sheda, National Environment Standards and Regulations Enforcement Agency (NESRA) and National Emergency Management Agency (NEMA)
- All developments are being carried under the watch of the International Atomic Energy Agency (IAEA).

3. Energy Supply: Where are we and from where? Cont'd

c) Renewables

– Renewable Energy sources such as Solar, Wind and Biomass have been used as traditional rather than commercial energy sources until of recent. Hydropower, a renewable energy source, however, has been utilized since 1929 by NESCO in Bukuru, Jos for off-grid electricity generation. About 2000 MW of hydropower has been installed mainly in Niger state (Kainji, Jebba and Shiroro). New installations of about 3,300 MW capacity are on the way at Zungeru and Mambilla as well as 30MW Gurara I, 40MW Kashimbila Dam, 150kW Waya Dam, 400kW Tunga Dam etc. There is also a 5MW Biomass (Rice Husk) fired power plant for Ebony State on the drawing board by UNIDO.

3. Energy Supply: Where are we and from where? Cont'd



Solar Map GIS

3. Energy Supply: Where are we and from where? Cont'd

d) Electricity/Power

- 1914 – 1960 (Colonial Era)
  - Public Works Department (PWD) of the Colonial Administration commenced operating electricity industry in Nigeria since 1896 with 60kW diesel generators;
  - In 1951, the Electricity Corporation of Nigeria (ECN) was established to take over from PWD & continued to supplied Administrative centres and industrial areas ;
  - About 50MW was put in place by 1960 mainly distributed generation using diesel fuel.
- 1960 - 1990 (Civilian Systems & Military Rules)
  - About 67% of this period was under Military rule;
  - 1960 – 1966 (Civilian Parliamentary System); 1966 – 1979 (Military); 1979 – 1983 (Civilian Presidential System); and 1983 – 1990 (Military)
  - While ECN continued to expand, Niger Dam Authority (NDA) was established in 1962 to cater for hydropower development;
  - ECN and NDA were merged in 1972 to form National Electric Power Authority (NEPA), a vertically integrated electricity company;
  - The electricity industry grew from about 50MW in 1960 to about 6000MW in 1990 with an average capacity growth rate of about 200MW/year

3. Energy Supply: Where are we and from where? Cont'd

Government Own Power Stations before Reforms

S/N	Plant	Year Commissioned	Fuel Type	Installed Capacity (MW)
1	Kainji	1968	Hydro	760
2	Jebba	1986	Hydro	578
3	Shiroro	1990	Hydro	600
4	Egbin	1985	Thermal Steam/NG, HPFO	1320
5	Sapele I	1978	Thermal Gas Turbine/NG	720
6	Sapele II	1981	Thermal Gas Turbine/NG	300
7	Ijora	1978	Thermal Gas Turbine/NG	60
8	Delta	1975	Thermal Gas Turbine/NG	912
9	Afam	1963	Thermal Gas Turbine/NG	711
10	Oji	1956	Coal	30
Total				**5991**

Source: ECN

3. Energy Supply: Where are we and from where? Cont'd

d) Electricity/Power

- 1990 – 1999 (Military)
  - Industry still managed by NEPA
  - National population grew and demand for electricity continued to grow
  - No new power plant was added to the grid within this period and there was decline in funding and performance
  - By the end of this period available power was below 2000MW
- 1999 – 2007 (Democracy under Presidential System)
  - Private sector driven economic policy initiated in 1999
  - In 2001, private sector driven electric power policy evolved
  - In 2005, the Electric Power Sector Reform Act was enacted that deregulated and liberalized the electricity industry in the country
  - With the ACT, NEPA was reformed into Power Holding Company of Nigeria (PHCN), which was unbundled into 18 sisters companies; 6 generation companies, 1 transmission company and 11 distribution companies in preparation for privatization.

3. Energy Supply: Where are we and from where? Cont'd

- Nigerian Electricity Regulatory Commission (NERC), regulator of the industry was established. Also, the Rural Electrification Agency (REA) was established. In order to fast tract increase in generation, transmission and distribution capacities, government initiated the National Integrated Power project (NIPP) in 2005;
- By the end of this period, installed grid generation capacity was raised to 7777.4MW with an average availability of 4156.19MW

– 2007 – 2010 (Democracy under Presidential System)
  - Power reforms implementation was sluggish within this period
  - Cost reflective electricity tariff referred to as the Multi Year Tariff Order (MYTO) was established by NERC
  - PHCN was the major driver of the electricity industry
  - At the end of this period, grid generation capacity increased to 8425.4MW with average availability of 4212.7MW

3. Energy Supply: Where are we and from where? Cont'd

- 2010 – Date (Democracy under Presidential System)
  - Power reforms got pursued with vigour within this period
  - Road Map for power sector reform was established and lunched in 2010 by the Presidential Action Committee on Power (PAC) to fast track the implementation of the power reforms through:
    - Removing obstacles to private sector investment
    - Clarifying government's strategy on the divestiture of PHCN successor companies and
    - Reforming the fuel – to – power sub-sector
  - The Nigerian Bulk Electricity Company referred to as the bulk trader was established as a transition instrument to go into power purchase agreement

3. Energy Supply: Where are we and from where? Cont'd

- The Nigerian Electricity Liability Management Company (NEMCO) was also established to assume and manage extant assets, liabilities, and other obligations that could not be easily transferred from PHCN to any of the successor companies
- Economic Tariffs (MYTO) established by NERC
- Feed-in Tariff (FiT) for renewables established by NERC to facilitate penetration of electricity from renewables
- By end of 2012, grid connected generation capacity was 9955.4MW with an average availability of 5516.38MW
- By end of 2013, all the 18 PHCN companies were successfully and transparently transferred to core investors, while the Transmission company was given to a Management Contractor;
- The generation plants of the NIPPs (10 No) are also being privatized through due process to core investors. Financial bids for the 10 power plant was opened on March 7th, 2014.
- Nigeria exports electricity to Benin and Niger Republics. For example, out of 29.6TWh of electricity generated in 2012, Benin and Niger Republics received 4.02% and 1.99%, respectively.

3. Energy Supply: Where are we and from where? Cont'd

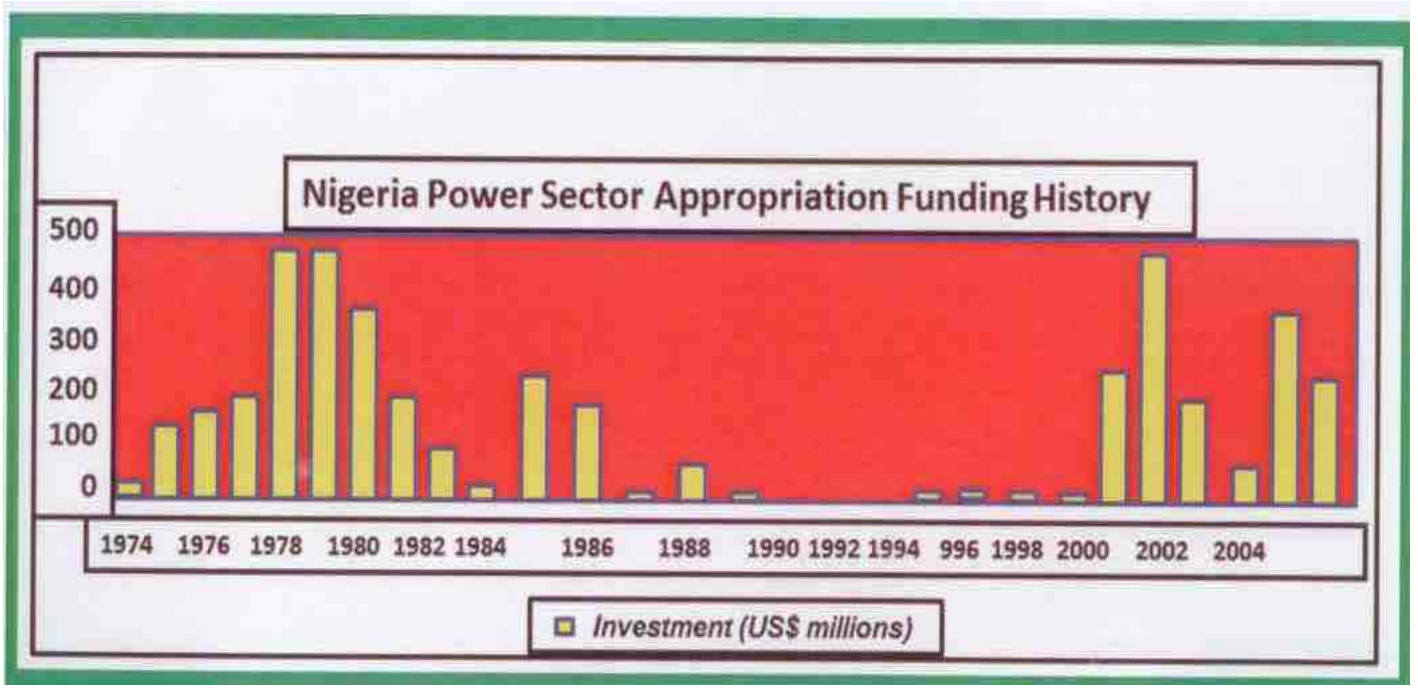
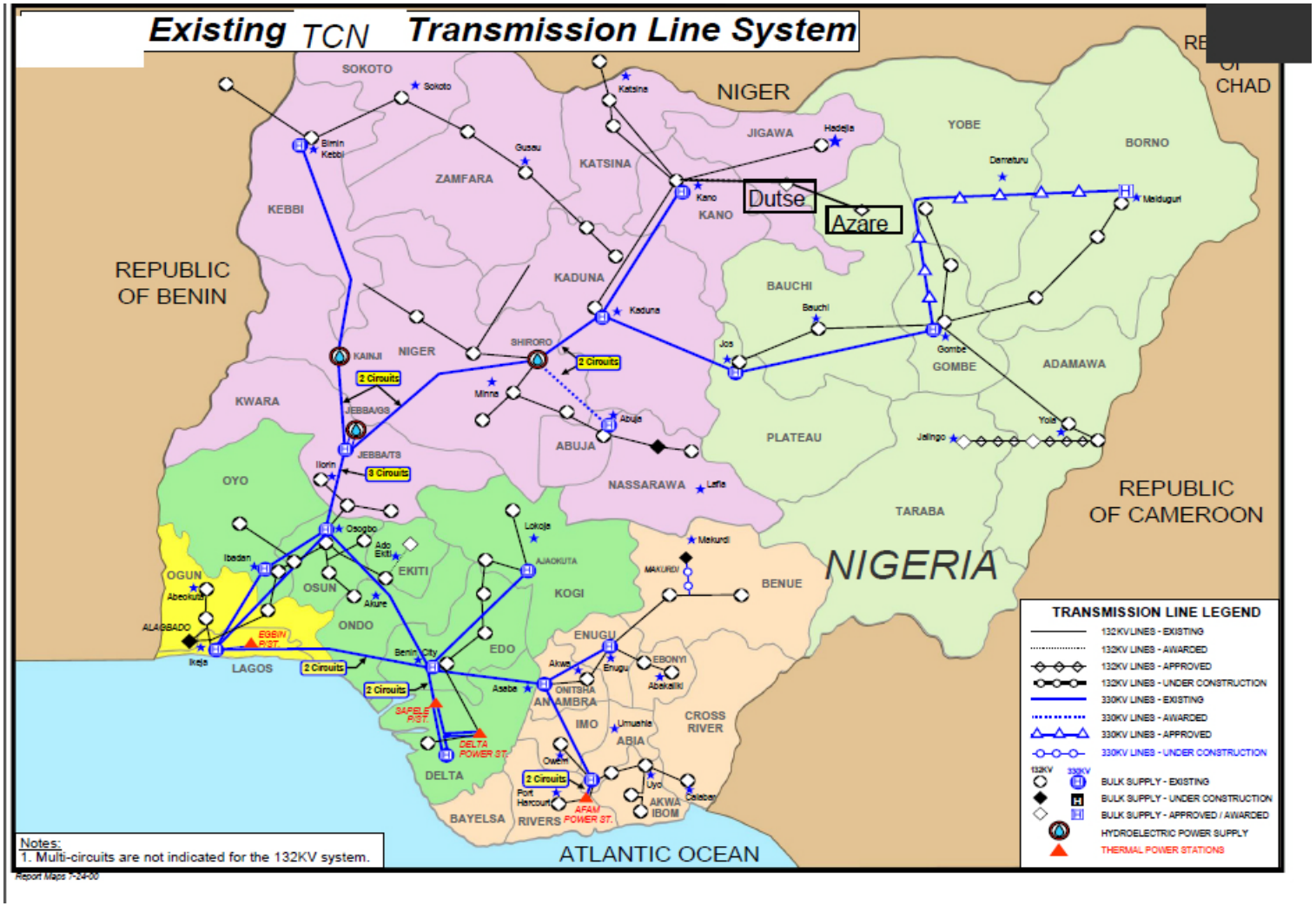


Figure 5. Power Sector Appropriation (1974 – 2007)

Source: FMP, 2014

3. Energy Supply: Where are we and from where? Cont'd



Transmission Lines System in Nigeria

3. Energy Supply: Where are we and from where? Cont'd

Grid Connected Power Plants 2010

SUMMARY OF GENERATION CAPABILITIES OF PHCN POWER STATIONS AS OPERATED IN THE YEAR 2010(JANUARY - DECEMBER)

POWER STATION	AVAILABILITY FACTOR (MW)	AVERAGE AVAILABILITY (MW)	INSTALLED CAPACITY (MW)
KAINJI HYDRO	0.54	412.55	760.00
JEBBA HYDRO	0.75	431.83	578.40
SHIRORO	0.65	390.21	600.00
EGBIN STEAM	0.62	819.55	1320.00
AJAOKUTA	0.00	0.00	110.00
A.E.S (GAS)	0.69	208.20	302.00
SAPELE ST	0.17	125.17	720.00
OKPAI GAS/	0.92	441.57	480.00
AFAM (I-V) (GAS)	0.04	21.56	516.00
AFAM VI (GAS)	0.67	435.64	650.00
DELTA (GAS)	0.38	342.95	900.00
GEREGU (GAS)	0.50	208.69	414.00
OMOKU GT	0.53	80.18	150.00
OMOTOSHO	0.36	118.93	335.00
TRANS-AMADI	0.33	32.63	100.00
IBOM	0.53	82.89	155.00
OLORUNSOGO	0.18	60.13	335.00
TOTAL	0.50	4212.70	8425.40

Source: National Control Centre, Osogbo (2010), Annual technical report

3. Energy Supply: Where are we and from where? Cont'd

Grid Connected Power Plants 2012

SUMMARY OF GENERATION CAPABILITIES OF PHCN POWER STATIONS AS OPERATED IN THE YEAR 2012(JANUARY - DECEMBER)

POWER STATION	AVAILABILITY FACTOR (MW)	AVERAGE AVAILABILITY (MW)	INSTALLED CAPACITY (LESS DE-COMMISSIONED UNITS) MW
PHCN - HYDRO STATIONS			
KAINJI HYDRO	0.39	295.38	760.00
JEBBA HYDRO	0.72	414.42	578.40
SHIRORO	0.83	497.46	600.00
SUB TOTAL	0.62	1207.26	1938.40
PHCN - THERMAL STATIONS			
EGBIN STEAM	0.77	1022.56	1320.00
AFAM (I-V) (GAS)	0.27	95.32	351.00
DELTA (GAS)	0.27	246.23	900.00
SAPELE ST	0.14	98.52	720.00
GEREGU (GAS)	0.66	274.96	414.00
OLORUNSOGO I	0.64	214.39	335.00
OMOTOSHO	0.34	113.02	335.00
SUB TOTAL	0.47	2064.99	4375.00
NIPP - THERMAL STATIONS			
OLORUNSOGO II	0.66	496.20	750.00
OMOTOSHO NIPP	0.29	144.73	500.00
SAPELE NIPP	0.58	218.26	375.00
SUB TOTAL	0.53	859.20	1625.00
IPP - THERMAL STATIONS			
RIVERS IPP	0.20	35.12	180.00
OMOKU GT	0.26	38.53	150.00
TRANS-AMADI GT	0.31	30.65	100.00
OKPAI GAS	0.92	440.86	480.00
IBOM	0.21	32.08	155.00
AFAM VI (GAS)	0.93	603.70	650.00
A.E.S (GAS)	0.68	203.99	302.00
SUB TOTAL	0.69	1384.93	2017.00
GRAND TOTAL	0.55	5516.38	9955.40

Source: National Control Centre, Osogbo (2012), Annual technical report

3. Energy Supply: Where are we and from where? Cont'd

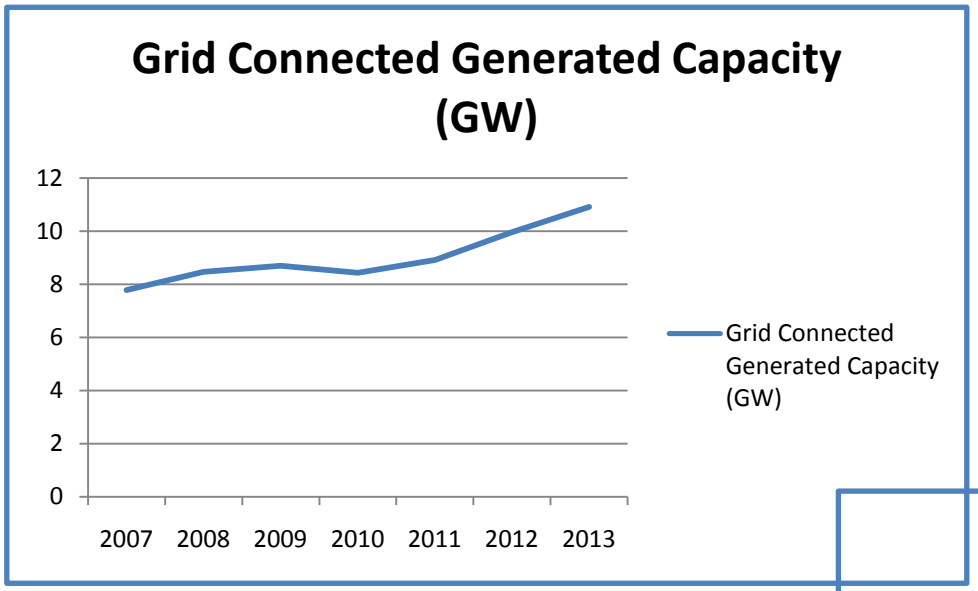
Grid Connected Power Plants 2013

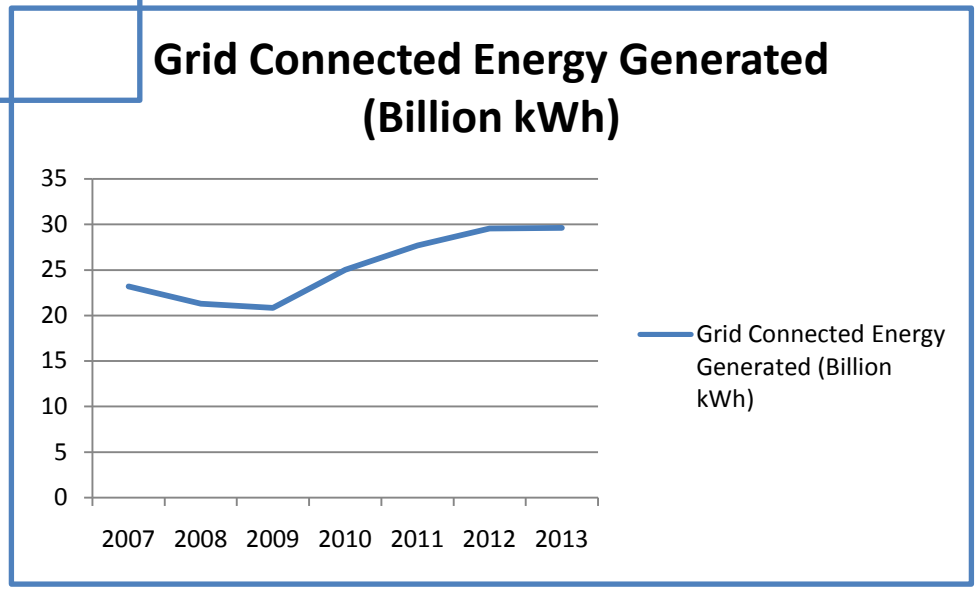
Summary of Generation Capabilities of PHCN Power Stations as Operated in the Year 2013 (January – December)

POWER STATION	AVAILABILITY FACTOR (MW)	AVERAGE AVAILABILITY (MW)	INSTALLED CAPACITY (LESS DE-COMMISSIONED UNITS) MW
PRIVATISED COMPANIES - HYDRO STATIONS			
KAINJI HYDRO	0.22	170.44	760.00
JEBBA HYDRO	0.66	381.39	578.40
SHIRORO	0.77	462.21	600.00
SUB TOTAL	0.52	1014.04	1938.40
PRIVATISED COMPANIES - THERMAL STATIONS			
EGBIN STEAM	0.74	976.77	1320.00
AFAM (I-V) (GAS)	0.17	58.57	351.00
DELTA (GAS)	0.27	246.78	900.00
SAPELE ST	0.13	94.32	720.00
GEREGU (GAS)	0.55	226.65	414.00
OLORUNSOGO I	0.43	144.34	335.00
OMOTOSHO	0.31	103.90	335.00
SUB TOTAL	0.42	1851.33	4375.00
NIPP - THERMAL STATIONS			
OLORUNSOGO NIPP	0.46	342.34	750.00
ALAOJI NIPP	0.00	0.00	150.00
GEREGU NIPP	0.42	189.74	450.00
IHOVBOR NIPP	0.08	20.11	250.00
OMOTOSHO NIPP	0.37	186.80	500.00
SAPELE NIPP	0.68	254.49	375.00
SUB TOTAL	0.40	993.49	2475.00
IPP - THERMAL STATIONS			
RIVERS IPP	0.51	91.81	180.00
OMOKU GT	0.00	0.00	150.00
ASCO	0.00	0.00	110.00
TRANS-AMADI GT	0.00	0.00	100.00
OKPAI GAS	0.85	409.70	480.00
IBOM	0.18	27.57	155.00
AFAM VI (GAS)	0.72	468.24	650.00
A.E.S (GAS)	0.65	194.82	302.00
SUB TOTAL	0.56	1192.14	2127.00
GRAND TOTAL	0.46	5050.99	10915.40

Source: Transmission Company of Nigeria, Annual Technical Report 2013

3. Energy Supply: Where are we and from where? Cont'd





3. Energy Supply: Where are we and from where? Cont'd

PHCN Successor Distribution Companies and their Core Investors

S/N	DISTRIBUTION COMPANY	STATES COVERED	CORE INVESTOR
1	Port Harcourt Electricity Distribution Company	Bayelsa, A/Ibom, C/River, Rivers	4Power Consortium
2	Abuja Electricity Distribution Company	FCT, Nasarawa, Niger, Kogi	KANN Utility Consortium Nig. Ltd
3	Benin Electricity Distribution Company	Ekiti, Edo, Ondo, Delta	VIGEO Power Consortium
4	Ikeja Electricity Distribution Company	Alimosho, Ikeja, Ikorodu	KEPCO Consortium
5	Enugu Electricity Distribution Company	Abia, Ebonyi, Anambra, Enugu, Imo	InterState Electrics Ltd
6	Ibadan Electricity Distribution Company	Ogun, Oyo	Integrated Energy Distribution Making Company
7	Jos Electricity Distribution Company	Bauchi, Gombe, Plateau, Benue	Aura Energy Limited
8	Kaduna Electricity Distribution Company	Kaduna, Zamfara, Sokoto	Yet to be sold
9	Kano Electricity Distribution Company	Kano, Katsina, Jigawa	Sahelian Power SPV Ltd
10	Eko Electricity Distribution Company	Festac, Ijora, Lagos Island, Ajah, Agbara/ Badagry District	West Power and Gas Ltd
11	Yola Electricity Distribution Company	Yobe, Taraba, Bornu, Adamawa	Integrated Energy Distribution & Marketing Ltd

3. Energy Supply: Where are we and from where? Cont'd

PHCN Successor Generating Companies & Core Investors

S/N	Name	Capacity (MW)	Core Investor
1	Afam Power Plc	987.2	Not yet finalized
2	Egbin Power Plc	1,320	Not yet finalized
3	Kainji Hydro Electric Plc	760	Mainstream Energy Solutions Ltd.
4	Sapele Power Plc	1,020	CMEC/EURAFRIC Energy Ltd.
5	Shiroro Hydro Electric Plc	600	North-South power Company
6	Ughelli Power Plc	942	Transcorp Ughelli Power PLC
Total		**5,629.2**	

3. Energy Supply: Where are we and from where? Cont'd

NIPP Generating Companies for Privatization

S/No	Name	Location	Capacity (MW)	Core Investor
1	Alaoji Generating Company Ltd	Aba, Abia State	831.3	Yet to be sold
2	Benin Generating Company Ltd	Benin City, Edo State	507.6	Yet to be sold
3	Calabar Generating Company Ltd	Calabar, Cross River State	634.5	Yet to be sold
4	Egbema Generating Company Ltd	Owerri, Imo State	380.7	Yet to be sold
5	Gbarani Generating Company Ltd	Yanegoa, Bayelsa State	253.8	Yet to be sold
6	Geregu Generating Company Ltd	Ajaokuta, Kogi State	506.1	Yet to be sold
7	Ogorode Generating Company Ltd	Sapele, Delta State	507.7	Yet to be sold
8	Olorunsogo Generating Company Ltd	Olorunsogo, Ogun State	754.0	Yet to be sold
9	Omoku Generating Company Ltd	Port Harcourt, River State	264.7	Yet to be sold
10	Omotosho Generating Company Ltd	Okiti Pupa, Ondo State	512.82	Yet to be sold
	Total		5,153.12	

3. Energy Supply: Where are we and from where? Cont'd

Independent Power Plants (IPPs)

S/ No	Name	Capacity	Location	Remarks
1	AES, lagos	300MW	Lagos State	grid connected
2	AGIP, Okpai	480MW	Delta State	grid connected
3	Obajana	350MW	Kogi State	self generation
4	Akute, lagos	12.5MW	Lagos State	self generation
5	Island, Lagos	10MW	Lagos State	self generation
6	Alausa, Lagos	10MW	Lagos State	self generation
7	Ibom Power	188MW	Akwa Ibom State	grid connected
Total		**1,350.5MW**		

3. Energy Supply: Where are we and from where? Cont'd

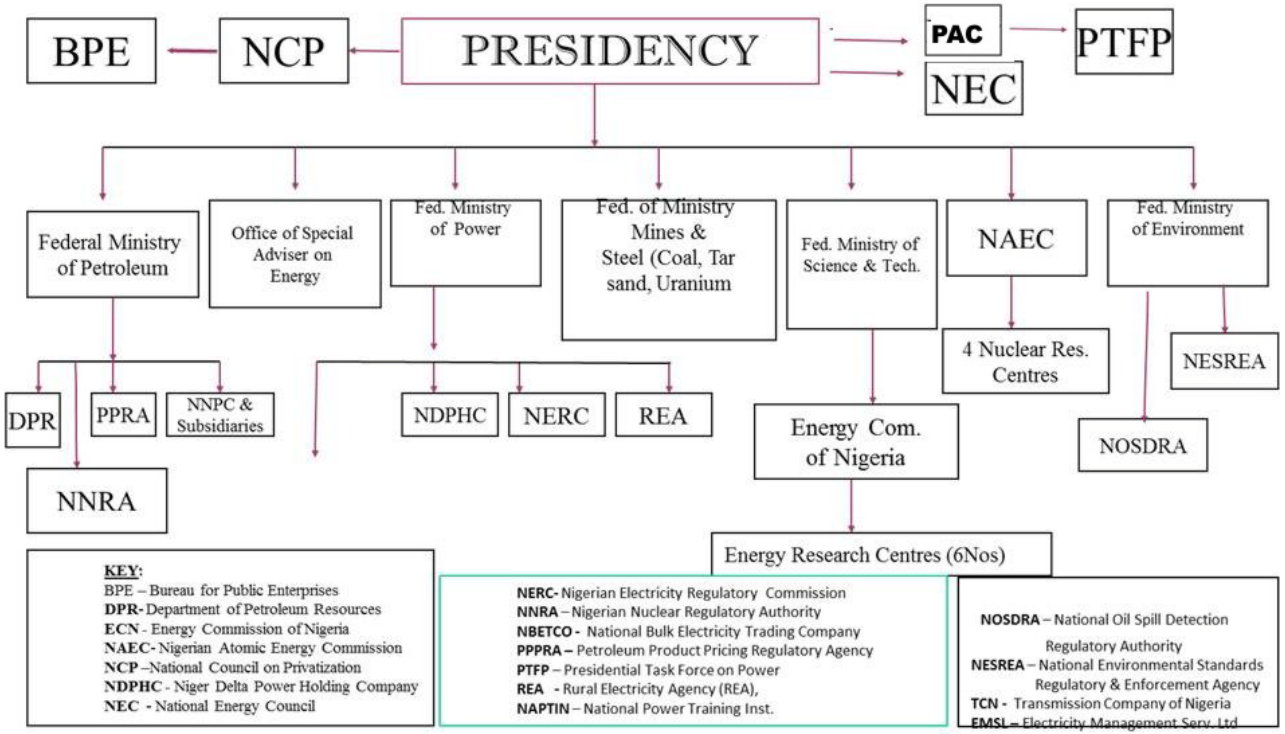
New FGN Power Plants

S/No	Name	Capacity	Location	Remarks
1	Zungeru Hydro	700MW	Niger State	On-going
2	Gurara I Hydro	30MW	Kaduna State	Completed
3	Gurara II Hydro	300MW	Niger State	Under Study
4	Kalamkasi hydro	40MW	Taraba State	On-going
5	Kaduna Thermal Power	200MW	Kaduna State	On-going
6	Mambila Hydro	2,600MW	Taraba State	Under study
7	Tunga Dam	400kW	Taraba State	On-going (UNIDO)
8	Waya Dam	150kW	Bauchi State	Completed (UNIDO)
9	Ezioha-Mgbowo	30kW	Enugu State	Completed(UNIDO)
Total		**3,870MW**		

3. Energy Supply: Where are we and from where? Cont'd

e) Current Institutional Framework in the Energy Sector

– Stakeholders Ministries, Department and Agencies in Nigeria.

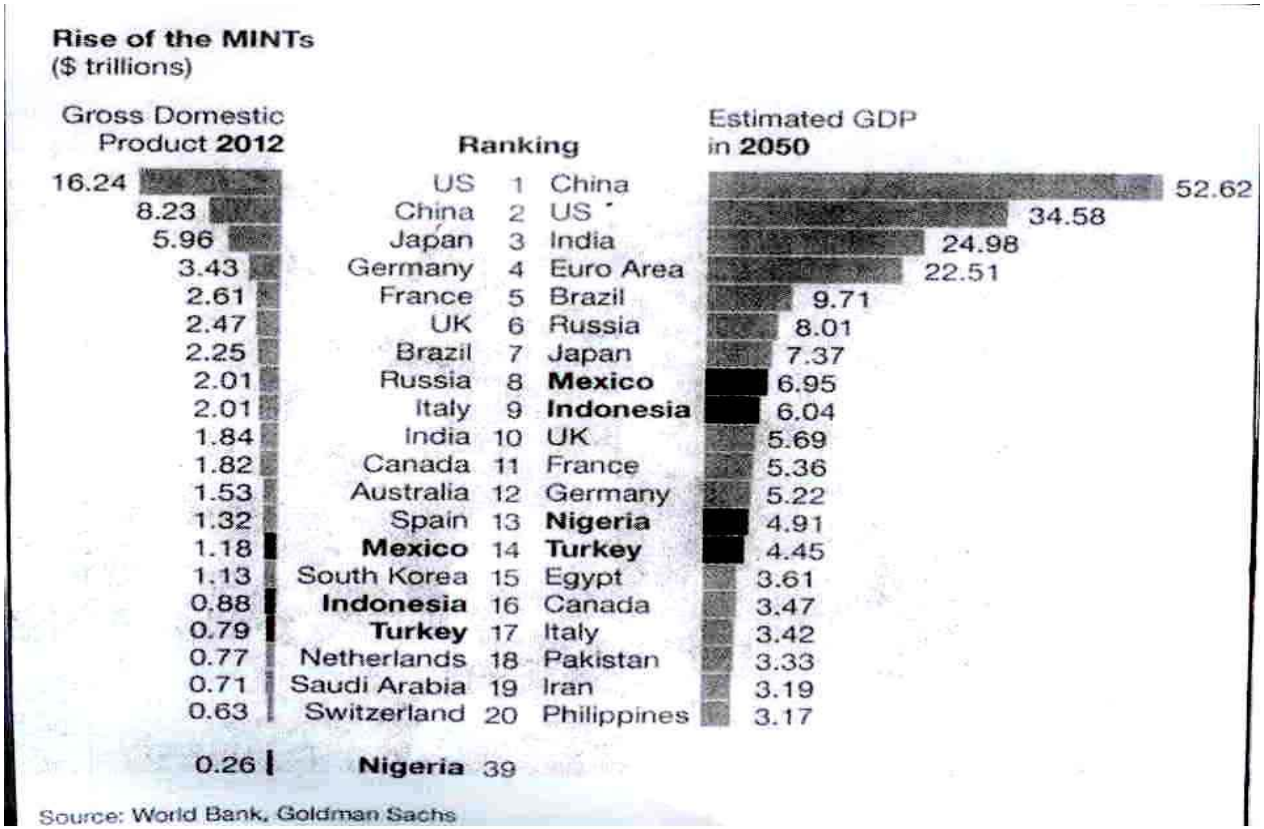


Institutional Framework in the Energy Sector in Nigeria as at 2014.

3. Energy Supply: Where are we and from where? Cont'd

- The Energy Commission of Nigeria, which I head, was established in 1979 by law. It however commenced operation in 1989 after the meeting of the Heads of ECOWAS on 29th May 1982 in Cotonou, where a decision was taken that each member state should establish by law, a body within the machinery of government, to be charged with the responsibility for coordinating and supervising all energy functions and activities within each Member State and may be called ENERGY COMMISSION of each Member State.
- The primary legal mandate of the ECN is to produce strategic plans and co-ordinate national policies on energy in all its ramifications.

4. Vision 20:2020: Where Do We Want to Be?



Nigeria's Ranking in the World based on GDP

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

- The Nation's vision is to be amongst the 20 large economies in the world by 2020. Nigeria was number 39 in 2012. However with the rebasing in 2013, we jumped to number 26. This upwards movement requires adequate, reliable and cost effective supply of electricity, fuels and process heat in the economy.
- This however must be done in a responsible and sustainable manner i.e the energy trilemma must be faced squarely.
- A study conducted by Energy Commission of Nigeria on Nigeria's long term energy demand and supply using IAEA energy planning tools of MAED and MESSAGE predicted huge amount of energy requirements under the following scenarios and assumptions:

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

The assumptions for the study are as follows:

Reference Growth Scenario:

- GDP grows by an average of 7% per annum.
- The main driver of growth is the manufacturing sector
- Manufacturing to account for 15% of GDP by 2020 from 4% in 2010
- Poverty to be reduced by half by 2015 in line with MDG objectives.

High Growth Scenario

- GDP grows by an average of 10% p.a.
- Manufacturing to contribute 22% to GDP by 2030 from 4% in 2010
- Nigeria transits from an agrarian to an industrializing economy

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

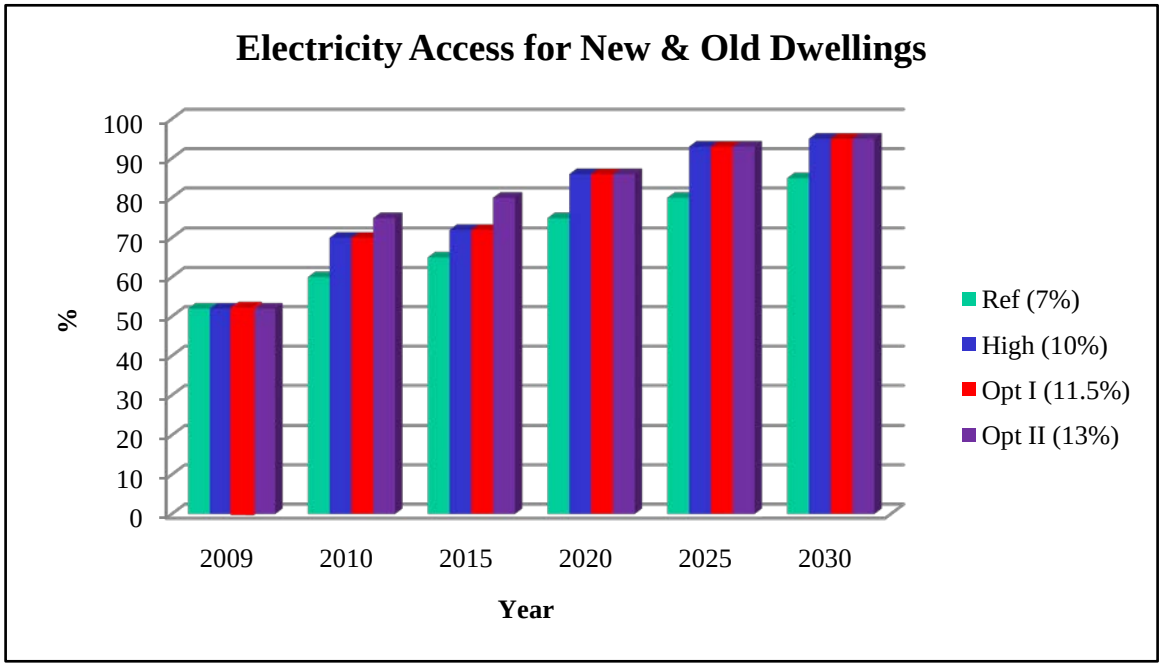
- **Optimistic Growth Scenario I**
  - GDP grows by an average of 11.5% p.a.
  - Manufacturing to contribute 22% to GDP by 2030 from 4% in 2010
  - Nigeria transits from an agrarian to an industrializing economy

- **Optimistic Growth Scenario II**
  - GDP grows by an average of 13% p.a.
  - Manufacturing to contribute 22% to GDP by 2030 from 4% in 2010
  - Nigeria transits from an agrarian to an industrialized economy

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Projected Electricity access for old and new dwellings (%)

Scenarios / Year	2009	2010	2015	2020	2025	2030
Ref (7%)	52	60	65	75	80	85
High (10%)	52	70	72	86	93	95
Opt I (11.5%)	52	70	72	86	93	95
Opt II (13%)	52	75	80	86	93	95



Projected Electricity Access

Source: ECN (2010)

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

a) Petroleum

- To have a conducive business environment for petroleum industry operations
- Have enhanced exploration and exploitations of petroleum resources for the benefits of Nigeria
- Optimized domestic gas supplies particularly for power generation and industrial development
- Have a progressive fiscal framework that encourages further investment in the petroleum industry, while optimizing the revenue accruing to government
- Established commercially oriented and profit driven O/G entities
- Deregulated and liberalized downstream petroleum sector
- Efficient and effective regulatory agencies
- Openness and transparency in the industry
- Enhanced local content in the petroleum industry.
- Oil reserves of 40 billion barrels and production of 4mb/d by 2020

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Projected Total Energy Demand for Fuel Petroleum Products for Nigeria

Year	PMS (Million litres)		DPK (Million litres)		AGO (Million litres)		Fuel Oil (Million litres)		LPG (Thousand tonnes)	
	7%	13%	7%	13%	7%	13%	7%	13%	7%	13%
2009	5096.9	5096.9	356.1	356.1	565.6	565.6	120.0	120.0	74.2	74.2
2010	6180.0	8890.0	464.0	902.0	791.7	1177.9	160.0	270.0	93.2	132.9
2012*									120	
2014*									250	
2015	14460.0	19510.0	3788.0	7039.0	2301.9	3651.0	1800.0	3380.0	1107.0	1871.2
2016*									500	
2020	28170.4	35587.1	9038.7	22704.5	4176.8	6270.8	4632.1	9277.9	2862.5	5733.5
2025	39769.4	55459.4	15084.9	44285.4	6231.8	11408.4	7806.1	20797.4	4824.0	12852.3
2030	56457.2	88369.2	22064.9	77255.7	8902.4	21349.7	11374.6	45443.4	7029.2	22903.7

Source: Energy Commission of Nigeria (2010)

* Punch 29th June 2014, pg 25

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

b) Coal/Lignites, Tar Sands/Bitumen and Nuclear Energy

- i) Coal and Lignite
  - To have a resuscitated coal industry through active private sector participation and with high local content
  - Adequate funding of coal to meet the energy and power requirement of the country in a cost effective and sustainable manner
- ii) Tar Sands/Bitumen
  - To have the tar sands/bitumen reserves explored and exploited through active private sector participation and high local content in an environmentally friendly manner for domestic and international markets
- Iii) Nuclear Energy
  - To have nuclear energy utilized for peaceful purposes
  - To have requisite manpower for peaceful use of nuclear power
  - To have adequate storage and disposal of nuclear waste in an safe and sustainable manner

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

c) Renewables and Energy Efficiency

- To have renewable energy mainstreamed into the nation's commercial energy mix through active participation of private sector and high local content
- To have renewables to contribute about 20% in meeting the electricity demand by 2030
- To have energy efficiency and conservation best practices promoted and its effect doubled by 2030

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Renewable Electricity Supply Projection in MW (13% GDP Growth Rate)

S/N	Resource	Now	Short	Medium	Long
1	Hydro (LHP)	1938	4,000	9,000	11,250
2	Hydro (SHP)	60.18	100	760	3,500
3	Solar PV	15.0	300	4,000	30,005
4	Solar Thermal	-	300	2,136	18,127
5	Biomass	-	5	30	100
6	Wind	10.0	23	40	50
	All Renewables	2025.18	4,628	15,966	63,032
	All Energy Resources	8,700 (installed Gen Capacity)	47,490	88,698	315,158
	% of Renewables	23%	10%	18%	20%
	% RE Less LHP	0.4%	1.3%	8%	16%

Short – 2015
Medium – 2020
Long – 2030

Source: ECN

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

(ii) Bio fuels Targets (Million Litres per Annum) for 13% growth scenario.

S/N	Item	Timeline/Quantity		
		Short	Medium	Long
1	Bio Ethanol (E10)	1951	3559	8837
2	Biodiesel (B20)	730	1254	4270

Source: ECN

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

d) Power

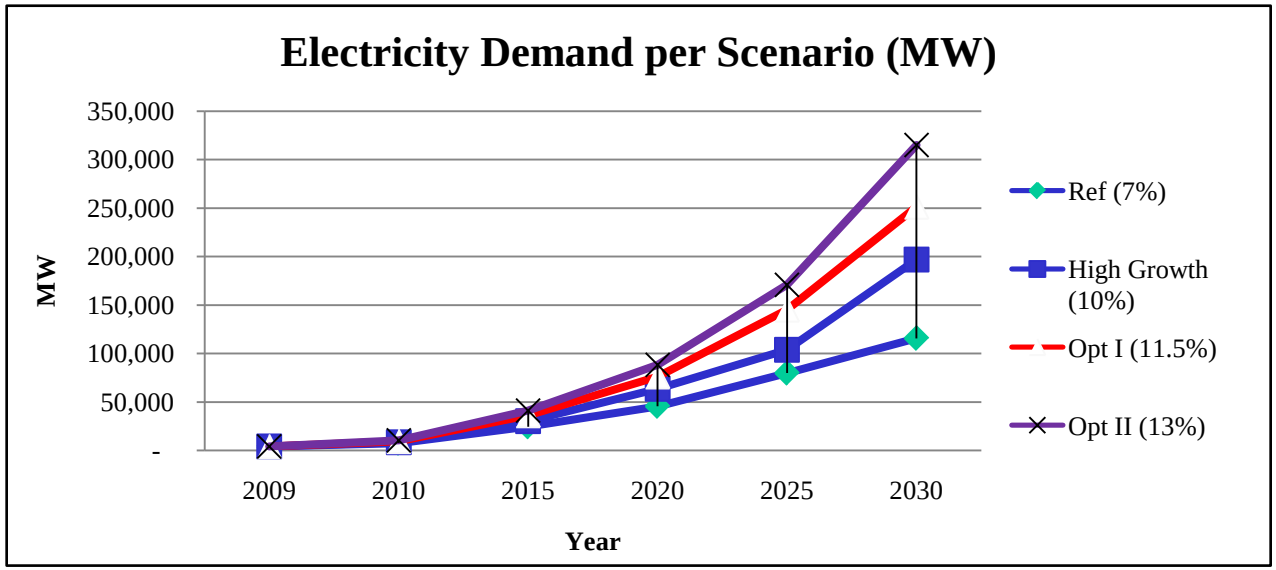
- That power contributes immensely to a double digit growth of the economy such that Nigeria becomes within the 20 largest economy in the world by 2020 or thereabout, through active private sector participation with high local contents and in an environmentally friendly manner. Projected power demand and supply for various scenarios from MAED and MESSAGE studies conducted are as shown in the following tables:

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Electricity Demand Projections for Nigeria under various Economic Scenarios

	2009	2010	2015	2020	2025	2030
Ref (7%)	4,052	7440	24380 (14,000)*	45490 (40,000)**	79798	115674
High Growth (10%)	4,052	8420	30236	63363	103859	196875
Opt I (11.5%)	4,052	9400	36124	76124	145113	251224
Opt II (13%)	4,052	10230	41133	88282	170901	315113

*Power Roadmap Target (PRMT) by 2014 ** PRMT by 2020



Source: ECN, 2012

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Electricity Supply Projections by Fuel Type : Optimistic II Scenario 7%

Fuel Type	2009	2010	2015	2020	2025	2030
Coal	0	609	1805	6527	7545	10984
Electricity import	0	0	0	0	0	31948
Gas	3803	4572	18679	33711	61891	80560
Hydro	1930	1930	3043	6533	6533	6533
Nuclear	0	0	1000	1500	2500	3500
Small hydro	20	60	172	409	894	1886
Solar	0	260	1369	3455	7000	25917
Wind	0	10	19	22	25	29
Biomass	0	0	3	16	35	54
Total	5753	7440	26092	52174	86422	161411

Source: ECN (2010)

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Electricity Supply Projections by Fuel Type : Optimistic II Scenario 10%

Fuel Type	2009	2010	2015	2020	2025	2030
Coal	0	870	2579	9324	10778	15691
*Electricity import	0	0	0	0	0	45640
Gas	3803	6957	21328	44763	82702	115086
Hydro	1930	2174	4348	9332	9332	9332
Nuclear	0	0	1500	2500	3500	3500
Small hydro	20	81	246	585	1277	2694
Solar	0	377	1956	4936	10000	37025
Wind	0	18	28	32	36	42
Biomass	0	0	4	23	50	77
Total	5753	10476	31989	71495	117675	229086

Source: ECN (2010)

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Electricity Supply Projections by Fuel Type : Optimistic II Scenario 11.5%

Fuel Type	2009	2010	2015	2020	2025	2030
Coal	0	1000	2966	10723	12395	18045
Electricity import	0	0	0	0	0	52486
Gas	3803	8000	23377	45728	106607	132348
Hydro	1930	2500	5000	10732	10732	10732
Nuclear	0	0	2500	4500	5500	6369
Small hydro	20	93	283	672	1469	3098
Solar	0	434	2250	5677	14127	42578
Wind	0	20	32	36	42	48
Biomass	0	0	4	27	58	88
Total	5753	12047	36412	78095	150929	265794

Source: ECN (2010)

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Electricity Supply Projections by Fuel Type: Optimistic II Scenario 13%

Fuel Type	2009	2010	2015	2020	2025	2030
Coal	0	3353	3353	12122	14011	20399
Electricity import	0	0	0	0	0	59333
Gas	3803	13110	26426	49996	120512	164307
Hydro	1930	4157	11207	12132	12132	12132
Nuclear	0	0	3600	7200	7200	7200
Small hydro	20	105	320	760	1660	3502
Solar	0	490	2543	6417	15970	48132
Wind	0	23	36	41	47	54
Biomass	0	0	5	30	65	100
Total (supply)	5753	21238	47490	88698	171598	315158

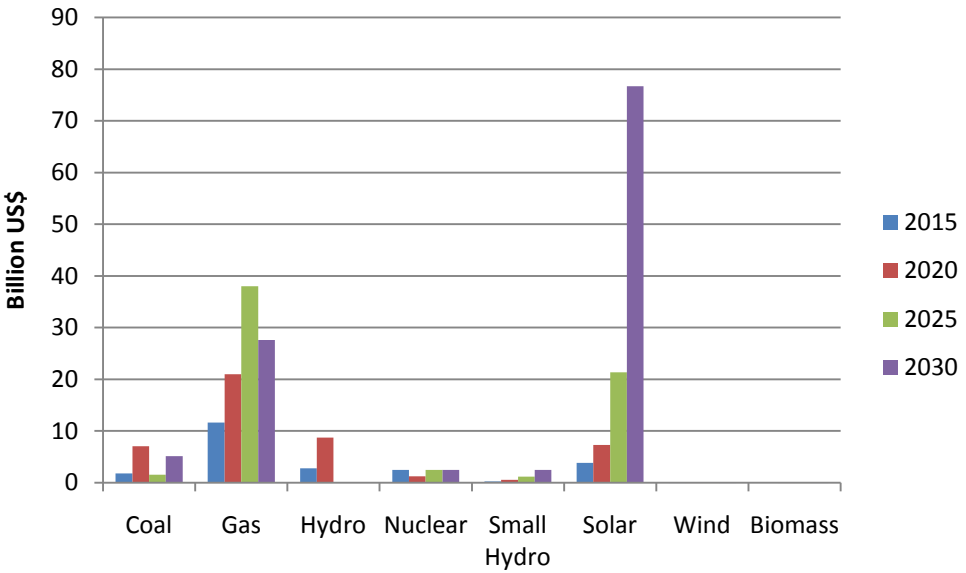
Source: ECN (2010)

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Capital Cost of Additional Generating Capacity by Technology in Billion US Dollars for the Reference Scenario

Resource	2015	2020	2025	2030
Coal	1.79	7.08	1.53	5.16
Gas	11.67	20.98	37.99	27.61
Hydro	2.78	8.73	0	0
Nuclear	2.5	1.25	2.5	2.5
Small Hydro	0.28	0.59	1.21	2.48
Solar	3.88	7.3	21.35	76.67
Wind	0.02	0.01	0.01	0.01
Biomass	0	0.02	0.03	0.03
Total	22.94	45.96	64.62	114.46

Source: ECN (2010)

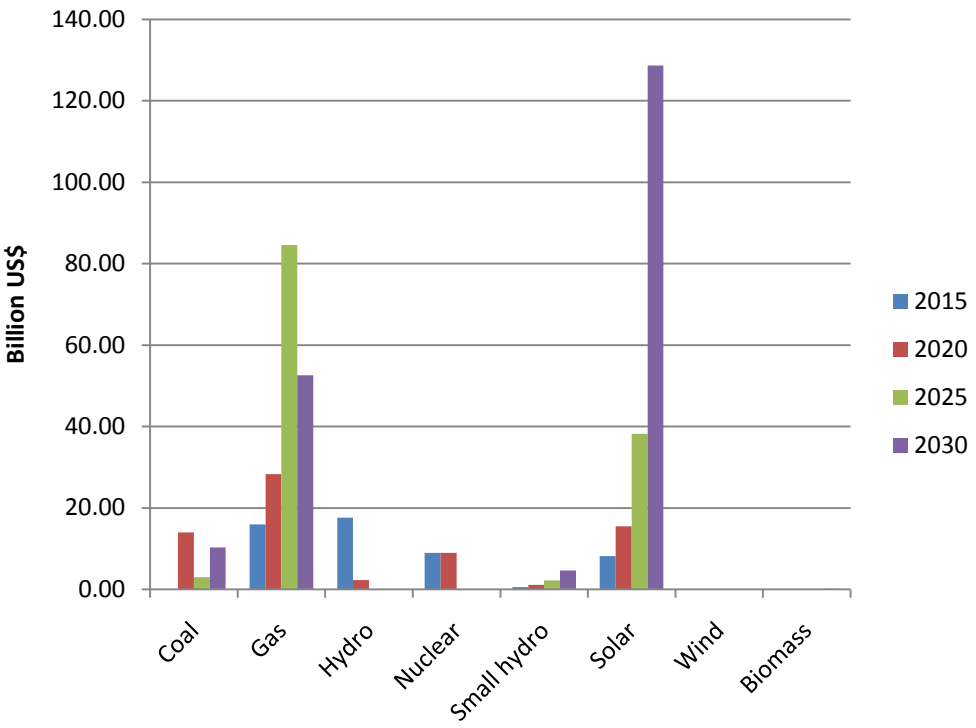


Capital Cost of Additional Generating Capacity by Technology in Billion US Dollars for the Reference Scenario

4. Vision 20:2020: Where Do We Want to Be? Cont'd…

Capital Cost of Additional Generating Capacity by Technology in Billion US Dollars for the Optimistic II Scenario (13%)

	2015	2020	2025	2030
Coal	0.00	14.03	3.02	10.22
Gas	15.98	28.28	84.62	52.55
Hydro	17.63	2.31	0.00	0.00
Nuclear	9.00	9.00	0.00	0.00
Small hydro	0.54	1.10	2.25	4.61
Solar	8.21	15.50	38.21	128.65
Wind	0.03	0.01	0.01	0.01
Biomass	0.01	0.06	0.08	0.08
Total	51.39	70.29	128.19	196.12



Source: ECN (2010)

Capital Cost of Additional Generating Capacity by Technology in Billion US Dollars for the Optimistic II Scenario (13%)

5. Energy Technologies for Sustainable Dev. In Nigeria

a) Hydropower

Nigeria with a hydropower potential of about 15,000MW has about 2000MW only exploited. A large unexploited potential therefore exists that needs to be developed fully. For example, the Zungeru, the Mambila, the Gurara II, the Dadin Kowa dam, the Tiga Dam, the Kasimbila and many other small hydro power sites in addition to cascading existing sites. It is expected that about 14,000MW of hydro should be available by 2020 if our dream is to come true.

5. Energy Technologies for Sustainable Dev. In Nigeria ..contd

Penstock bifurcation into the 150 kW power house at Waya Dam, Bauchi State

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

b) **Solar Energy:**

Solar energy has the greatest potential to contribute enormous amount of low carbon energy in Nigeria through solar PV and solar thermal process. It may be transformed directly into heat using solar collectors or directly to electricity using solar PV cells. It is estimated that about 6,000MW of solar electricity be put in place by 2020. however, only about 15MW of dispersed solar PV systems are on ground.

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

Solar PV Systems

3kW solar PV mimi-grid in Talasse General Hospital, Balanga LGA, Gombe State (2013)

Solar PV powered Water Borehole in Abule Kajola, Akute, Ifo LGA, Ogun State (2013)

Solar PV Streetlight in Omiadio, Ido LGA, Oyo State (2013)

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

2.5 MW Solar PV, in Sal, Cape Verde
Commissioned October 1, 2010

5 MW Solar PV, in Praia, Cape Verde
Commissioned November 2, 2010

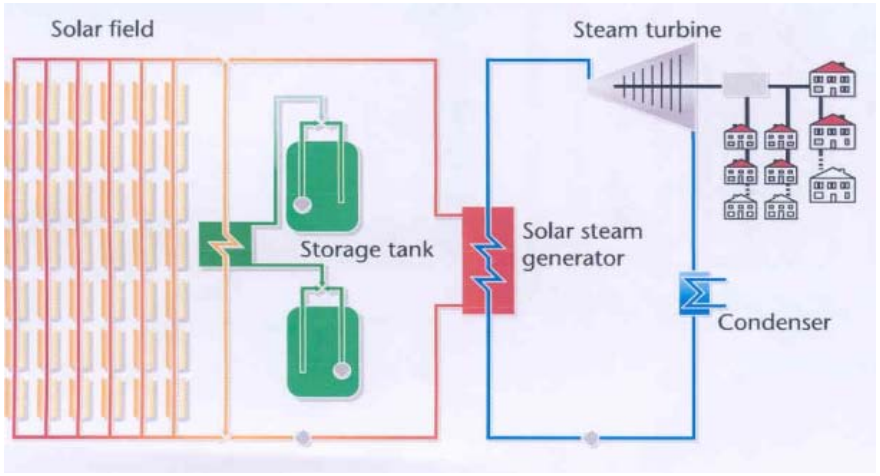
Source: ECREE (2011)

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

Solar Thermal Power Generation

Solar thermal Plant in Spain (Heliostat)

50 MW Solar thermal Plant in Spain (Parabolic)



Rankine Cycle

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

Solar Water Heater

Pilot Water Heater at UDUTH by SERC, Sokoto

Solar Water Heater developed by NCERD

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

c) Wind Energy

Nigeria's wind resource of 2-4m/s at 10m height is considered low for wind farm electricity generation using conventional wind generations. However, at higher heights greater wind speeds may be encountered, where reasonable electricity could be generated there from. It is envisioned that about 40MW of wind electricity would be needed by 2020. However, a 20MW wind farm is in place in Katsina state.

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

150MW Osario Wind Farm, Brazil

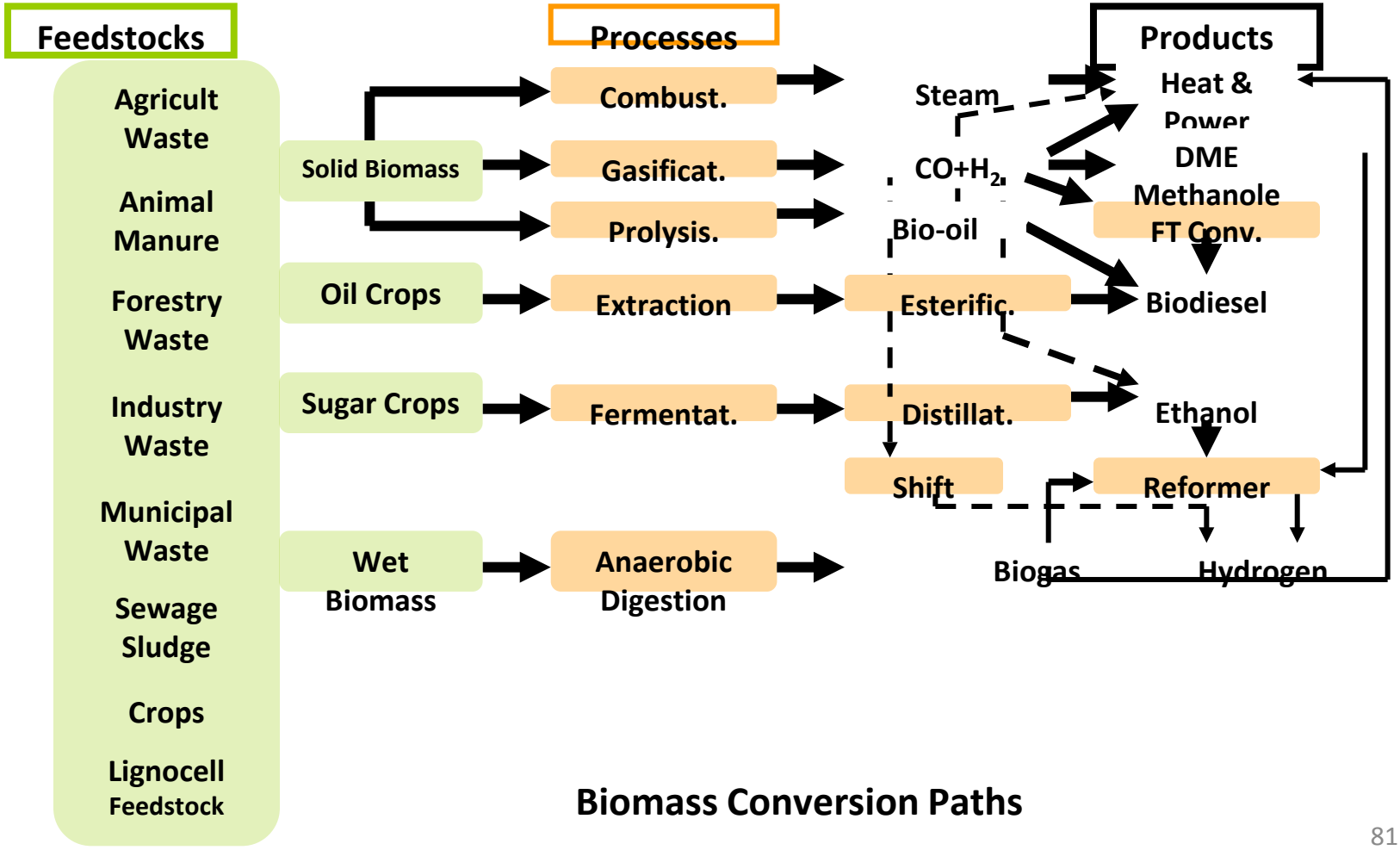
305 MW Wind Farm at Zanfrana, along the Red Sea, Egypt

5kW aero generator in Sayya Gidan Gada, Sokoto State

Drag Type wind Turbine for Water Pumping

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

d.) Biomass Conversion Technologies: Biomass refers to organic matter of non-fossil type



Biomass Conversion Paths

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

- Biomass/biogas/biofuel Cont'd…
  - Power generation from rice husk(5MW in Ebonyi state)
  - Biogas generation for heating & power generation
  - Municipal waste-to-power
  - Biofuels (ethanol &biodiesel) from Sugarcane, Jatropha, cassava & Lignocellulolistic feedstocks – use of E10 & B20 approved by FEC.
  - Fuelwood lots development
  - it is expected that about 30MW of biomass electricity be available in our electricity supply mix by 2020

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

Sludge

Biogas Digester

Power House

Generating Plant

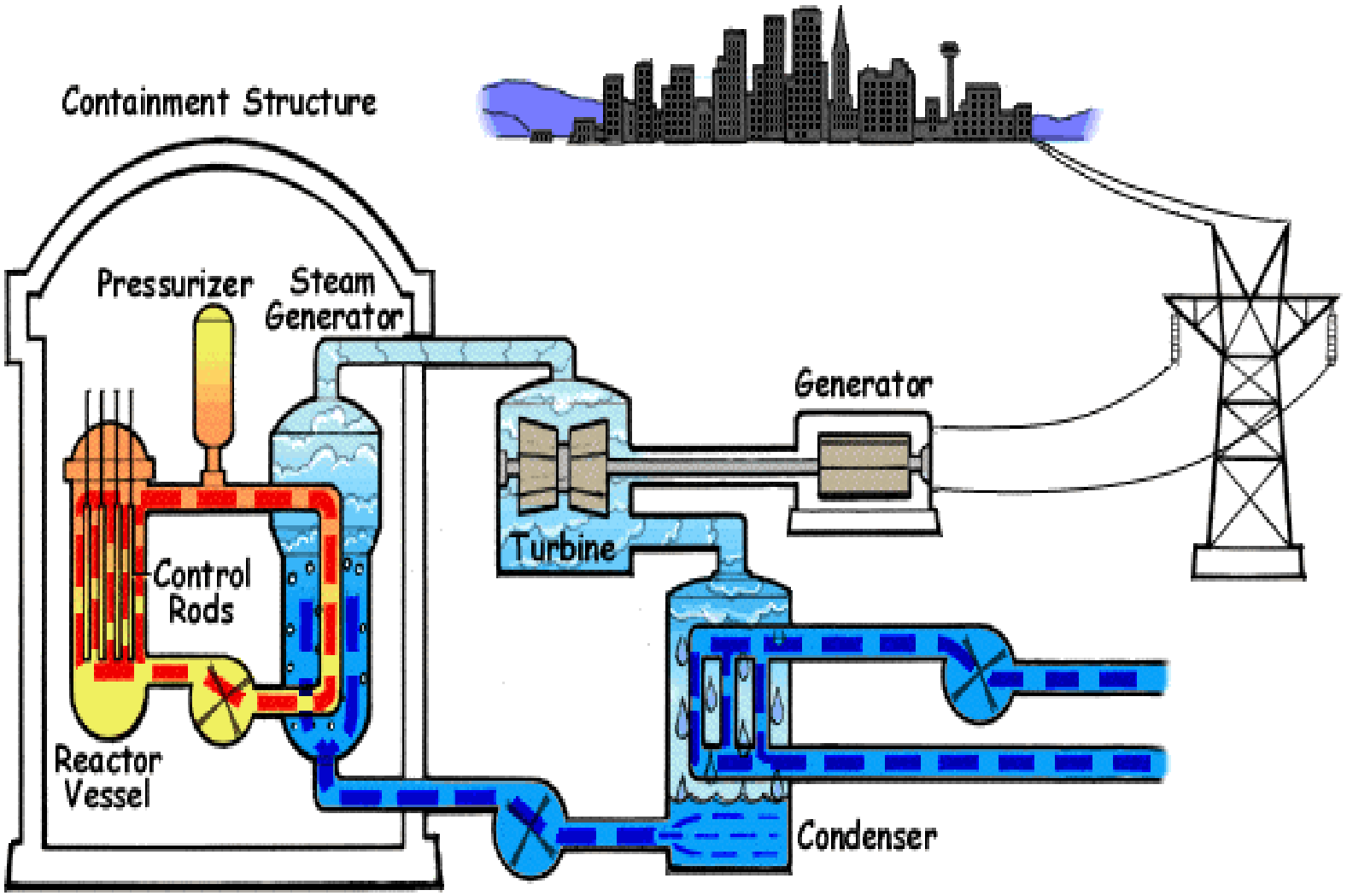
A 750 kW Plant for Biogas Electricity Generation in Germany

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

e) Nuclear Energy:

With an Atomic Energy Commission and a Nuclear Regulatory Authority, negotiations for nuclear power through IAEA in meeting the electricity needs of our country is on. It is expected that about 7000MW of nuclear power be provided in the economy by 2020. However, 1000MW only is being planned for the period by NAEC.

5. Energy Technologies for Sustainable Dev. In Nigeria..contd



Typical PWR Power Plant System

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

f) Natural gas:

With the huge natural gas reserves in the offshore, onshore as well as potentials in the inland basins of Sokoto, Bida, Chad, Benue trough, Anambra etc, natural gas therefrom can be utilized for power generation and other industrial uses. It is expected that about 50,000MW capacity driven by natural gas be made available by 2020. However, about 9,000MW have been put in place.

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

414 MW Natural Gas Fired Power Plant, Geregu, Kogi State - NIPP

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

g) Clean Coal Technologies

The exploitation of coal, in the 14 states with coal potentials, for electricity generation, industrial heating and domestic applications using clean coal technologies would bring a lot of economic and environmental benefits. It is expected that about 12,000MW of clean coal power be made available by 2020. However, 1000MW is being planned by FMPower.

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

h) Energy Demand Management

Demand for energy should always be kept at a minimum through:

- Use of energy audit to identify and rectify areas of energy wastage
- Labeling of appliances according to efficiency levels as a guide
- Use of efficient energy appliances like CFLs, LEDs, improved woodstove, efficient refrigerators and air-conditioners, electric motors etc.
- Use of combine cycle power plants to improve overall power efficiency (integrated solar combine cycle (ISCC) & (IGCC)

. It is expected that over 60% of the energy systems in use, be over the minimum energy efficient standard set by 2020

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

Retrofitting ECN Building with LED Lamps to half the lighting load of the building (UNDP-GEF Energy Efficiency project)

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

Improved firewood Clay cook stoves

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

Developmental Association for Renewable Energies (DARE) 80 % Efficient Wood Stove

5. Energy Technologies for Sustainable Dev. In Nigeria..contd

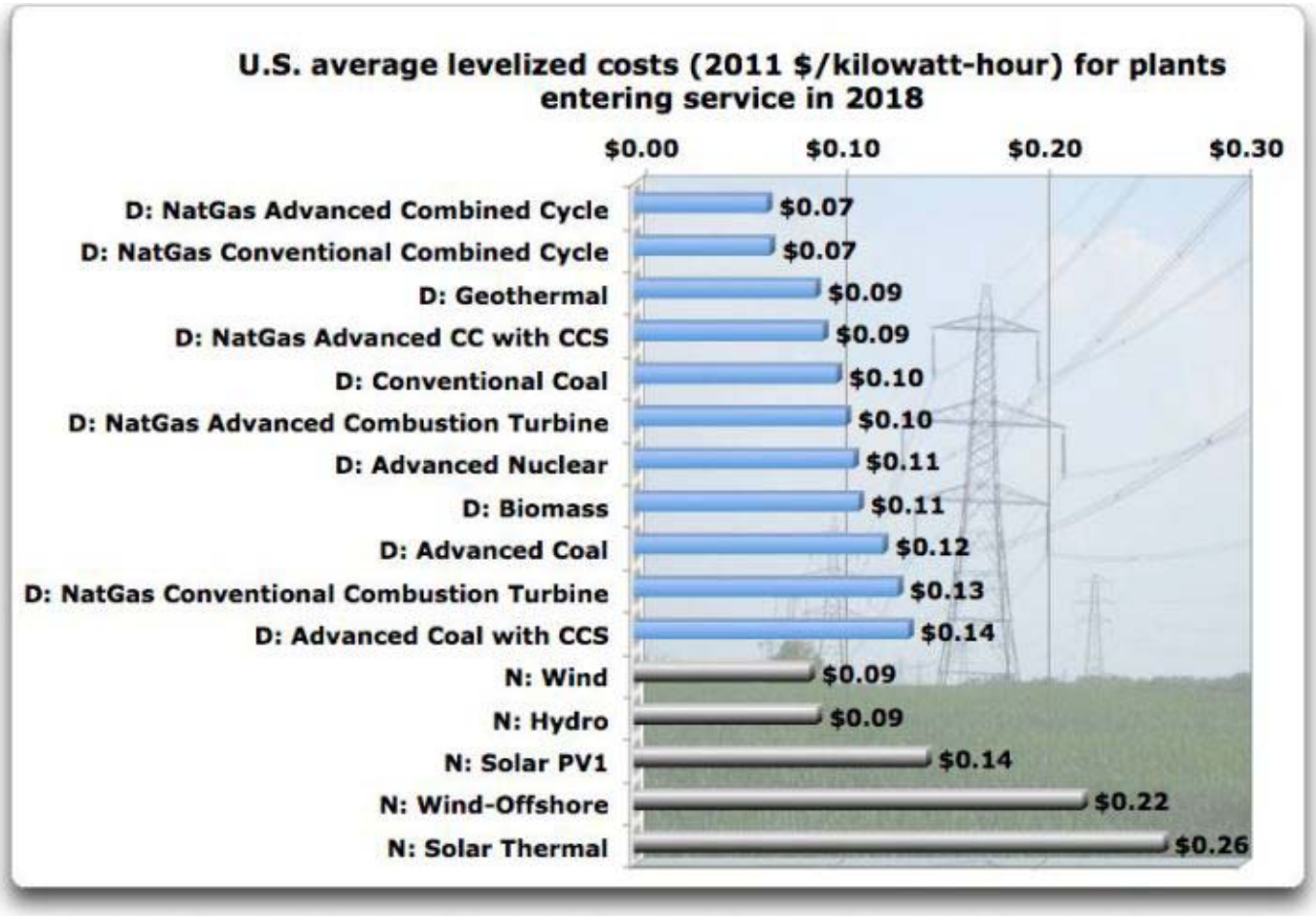
Estimated Capital Cost of Power Generating Plant Technologies (USD per kW)

	Technology	Year on line	Cost ($/kW)
	Advanced open cycle gas turbine	2008	398
	Conventional open cycle gas turbine	2008	420
	Advanced gas/oil combined cycle	2009	594
	Conventional gas/oil combined cycle	2009	603
	Distributed generation (base load)	2009	859
	Distributed generation (peak load)	2008	1032
	Advanced combined cycle with sequestration	2010	1185
	Wind	2009	1208
	Coal-fired plant with scrubber	2010	1290
	IGCC	2010	1490
	Conventional hydropower	2010	1500
	Biomass	2010	1869
	Geothermal	2010	1880
	Advanced nuclear	2011	2081
	IGCC with carbon sequestration	2010	2134
	Solar thermal	2009	3149
	Fuel cell	2009	4520
	Photovoltaic	2008	4751

	Technology	Capacity factor (%)
	Gas turbine combined cycle	80-90
	Nuclear	90
	Average US coal plant	68
	Biomass	68
	Geothermal	90
	Hydropower	44
	Wind turbine	30
	Solar	20

Source: https://cdm.unfccc.int/filestorage/Q/5/7/Q57ASVXOICJUZYH9RWNBEPF4D13KT8/4118%20Estimated%20Capital%20Cost%20of%20Power%20Generating%20Plant%20Technologies.pdf?t=R2t8bmV0bzhjfDAP3EfQkRpWfuVWjBG3h3Hp

5. Energy Technologies for Sustainable Dev. In Nigeria..contd



Source: http://wattsupwiththat.com/2014/02/16/the-levelized-cost-of-electric-generation

6. Prospects and Challenges for Sustainable Energy in Nigeria

a) Prospects

i. There is high potential for growth in sustainable energy development because of the opening of the energy sector for private sector participation from the on going reforms, particularly the electricity subsector which is backed by law.
ii. No hindrance to repatriation of profits as an incentives to investors.
iii. Nigeria has a large local energy market as well as serves as a hub for the sub region.
iv. Some fiscal and financial incentives are available for sustainable energy development.
v. Pressure from the climate change adversaries enhances prospects for sustainable energy development in Nigeria.

b) Challenges

i. Inadequate local indigenous human and manufacturing capacities
ii. Inadequate incentives
iii. High initial investment cost for sustainable energy technologies
iv. Access to finance

7. Conclusion

- Nigeria is endowed with fossil and renewable energy sources. Crude oil and natural gas are being fully exploited now, and contribute over 70% of the Nation's foreign exchange earnings as well as major contributor to GDP. While crude oil production stands about 2mb/d, supply of petroleum products are, however , mainly from imports due to very low capacity utilisation of the domestic refineries. With current reserves and production rates, crude oil and natural gas maybe sustained for 52 years and 61 years, respectively. Coal deposits are sparingly being exploited.

- In view of the finiteness of fossil fuels coupled with their negative effects on the ecosystem and climate change, diversification of the nation's energy supply mix to include renewable energy endowment of solar, hydro, biomass and wind as well as nuclear energy backed by energy efficiency and conservation best practices becomes imperative for driving sustainable development in the country.

- Income derived from depletable fossil energy resources should be invested to develop the renewable energy endowment and nuclear as well as best practices in energy efficiency and conservation to enhance our energy security.

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Thank you
and
God Bless