

Covenant University

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POSITIONING THE ELECTRIC POWER SECTOR FOR ELECTRICITY SUFFICIENCY IN NIGERIA TO MEET UP WITH VISION 2020.

Joseph C. Ekeh

Public Lecture Series

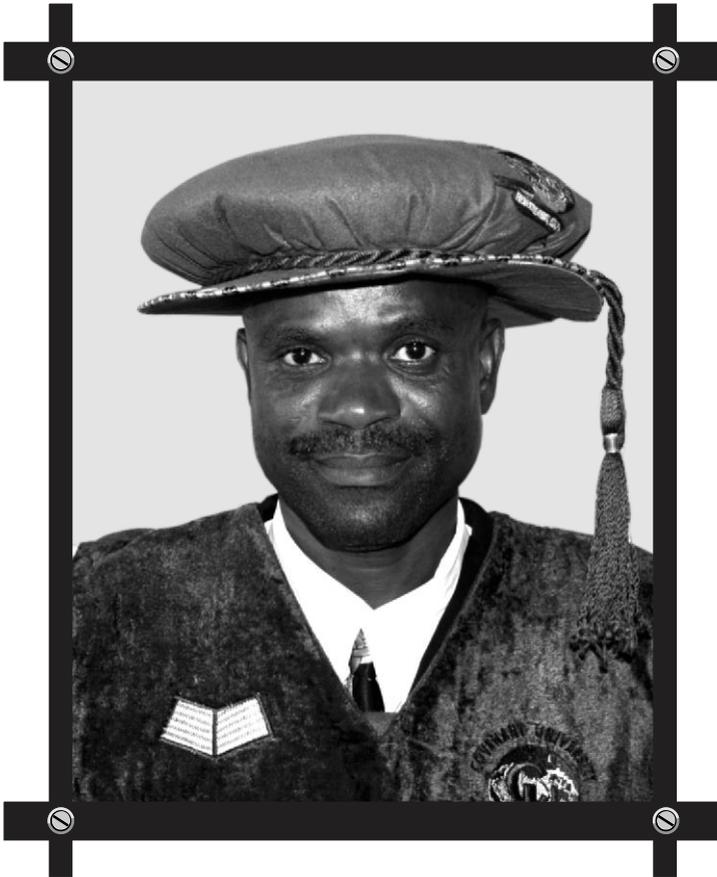


Positioning the Electric Power Sector for Electricity Sufficiency in Nigeria to meet up with Vision 2020.

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INTRODUCTION

“In the beginning God created the heavens and the earth. Now the earth was formless and empty, darkness was over the surface of the deep, and the Spirit of God was hovering over the waters. And God said, *let there be light, and there was light*. God saw that the light was *good*, and he separated the light from the darkness. God called the light day, and the darkness he called night. And there was evening, and there was morning – the first day” [1].

Electricity, of which Light is a product is the whole essence of life. This informed God's decision to command light into existence before the creation of all other things. Unfortunately, the *undertakers* of our electric power sector will not allow this beautiful idea of God to work in this country [2].

Electricity is not a primary source of energy; however, it is one of the most versatile forms [3]. It is known to play a significant role in the advancement of the standard of life of mankind. The electricity per capita consumption has a strong correlation with national Gross Domestic Product (GDP). Available evidence shows that a robust power supply has high positive multiplier effect on the entire economy. With her tremendous potentials in material and human resources, Nigeria lags behind in the provision of needed electricity [4].

Electricity is an engine for growth for industrialization, manufacturing and the running of the basic needs such as food, health and water. Thus electricity can be described as a *hub* of the economy. No wonder one of the seven – point agenda of Mr.

President, Alhaji Umaru Musa Yar'Adua on assumption of office on May 29, 2007 is *power and energy*. Others *food security, wealth creation, human capital development, mass transit, security and land reform* revolve around power and energy.

Inadequate and unreliable electricity is a threat to social and economic life. It deters investors, entrepreneurs and managers. It is an obstacle to business as it increases the cost of doing business, business risk and uncertainty of investment. Indeed, electricity is not just an intrinsic aspect of development, it is also an essential pre – condition for sustainable development since no meaningful socio – economic growth can be attained without it. In the word of Mr. President, “without adequate and reliable electricity generation, no nation can transform into a modern economy”.

Inadequate and unreliable electricity is a hindrance to food security, wealth creation, human capital development, mass transit, and security. If we insist that by the year 2020, barely twelve years from now, our economy is expected to join the world's twenty largest economies in GDP size, then the electricity issue must be considered the top most of priorities. If we fail in this sector, we can as well bid farewell to any aspirations towards 2020.

THE VISION NECESSITY

The word *Vision* has been in existence since the creation of man. It first appeared in the Holy Book, the Bible in Genesis 15:1 and I quote: “After this, the word of the Lord came to Abram in a Vision: Do not be afraid, Abram. I am your shield” [5]. It is through Vision that this citadel of learning and centre of

excellence, the Covenant University, Ota, Ogun State was conceived by God's Servant, Dr. David Oyedepo.

According to the Oxford Advanced Learner's Dictionary [6], the word Vision has so many meanings. One such definition is 'the ability to see; the area that you can see from a particular position'. Another definition is that, 'Vision is a dream or similar experience, especially of a religious kind'. Also, Vision is defined as 'the ability to think about or plan the future with great imagination and intelligence'.

In his paper at the Executive Advance, 2008, titled: “The Vision and Mission of Covenant University” [7], Dr. David Oyedepo, the Chancellor and Chairman, Board of Regents, Covenant University, Ota and Presiding Bishop of the World's largest Church Auditorium, Faith Tabernacle/ Living Faith Church (a.k.a, Winners' Chapel) presented the following:

- “If any man has no purpose for living, he is not fit to live”. –Martin Luther King, Jnr.
- In the same vein if anything has no purpose for existence it is not fit to exist. It surely takes a well defined Vision to command an enviable result.
- “Where there is no Vision the people perish but he that keeps to the vision happy is he”. Proverb 29:18.
- Without a vision is a people made naked. This implies that vision is the custodian of the colour and beauty of any individual, organization or institution.

Therefore, Vision 2020 aimed at Nigeria becoming one of the 20 largest economies in the world by GDP and by that, the financial hub of Africa is a welcome idea. But the question is this: how is

the Federal Government of Nigeria under the leadership of Alhaji Umaru Musa Yar' Adua prepared to realize such Vision? This is the thrust of this public lecture.

To keep the Vision on track, the Financial System Strategy 2020 (FSS 2020) has been inaugurated as the pivot for the actualization of the Vision. Also, the Government has initiated other economic measures.

ELECTRICITY DEVELOPMENT IN NIGERIA

By way of background, the development of the Nigerian Electric Power Sector began in 1896 with the installation of a 20 MW power plant at Ijora, Lagos. In 1925, the Nigerian Electricity Supply Company (NESCO) commenced operations as an electric utility company with the construction of a 2 MW hydro plants at Kurra falls in Jos, Plateau State. The Electricity Corporation of Nigeria (ECN) was established in 1950 to oversee the electricity sector. As a result of rapid urbanization and the increasing demand for electric power, the Niger Dam Authority (NDA) was established to build and manage dams [3].

The merger of ECN with NDA was achieved through a Decree No.

24 promulgated in June 1972. The Decree became effective in January 1973, resulting in a single vertically integrated utility called *National Electric Power Authority* (NEPA). As a government owned monopoly, NEPA was mandated to generate, transmit, distribute and sell electricity throughout the nation. It is noteworthy that this was the first organized effort thrust of the Federal Government of Nigeria on the development of electricity in Nigeria. However, it lacked the comprehensive National

Energy Policy which addresses all the inherent peculiarities associated with the Nigerian nation to induce confidence in prospective investors in the power sector [8].

As at December 2006, the electricity industry had a total generating installed capacity of approximately 7060MW, out of which about 88% was owned by Power Holding Company of Nigeria (PHCN) whereas the remaining 12% was owned by the independent Power Producers (IPPs).

Table 1 gives the overall generating scenario in the country, including the projects under construction [9].

TABLE 1: Existing, on – going, and Proposed Electricity Generation Infrastructure in Nigeria [9]

TABLE 1
Existing, on – going, and Proposed Electricity Generation Infrastructure in Nigeria [9]

S/N	Name of Station	Capacity (MW)	Type of fuel	Year commissioned	Age of Plant (years)
A	Existing power Stations, Pre – 1999 Stations				
1	Kainji	760	Hydro	1968,1976,1978	23 - 33
2	Jebba	578	Hydro	1986	22
3	Shiroro	600	Hydro	1990	18
4	Egbin	1320	Thermal	1986,1986,1987	21 - 22
5	Sapele	1020	Thermal	1978,1981	27 - 30
6	Delta	912	Thermal	1966 – 1990	18 - 42
7	Afam	711	Thermal	1965 – 1982	26 - 43
8	NESCO	30	Hydro/thermal	1929	
	Sub total	5,931			
B	National Integrated Power Projects (NIPPs)				
9	Gbarain, Bayelsa	225	Thermal	Yet to be commissioned	
10	Ihonor, Edo	451	Thermal	Yet to be commissioned	
11	Omoku, Rivers	230	Thermal	Yet to be commissioned	
13	Sapele, Delta	451	Thermal	Yet to be commissioned	
14	Egbema, Imo	338	Thermal	Yet to be commissioned	
15	Calabar, Cross Rivers	561	Thermal	Yet to be commissioned	
16	Ikot Abasi, Akwa Ibom	300	Thermal	Yet to be commissioned	
17	Ibom Power, Awa Ibom	188	Thermal	Yet to be commissioned	
	Sub total	2,744			
C	Independent Power Producers (IPP)				
18	AES, Lagos	270	Thermal	2000	
19	Geregu, Kogi	414	Thermal		
20	Omosho, Ondo	335	Thermal		
21	Papalanto, Ogun	335	Thermal		
22	Alaoji, Abia	346	Thermal		
23	Geometric, Aba	140	Thermal		
24	Agip JV, Okpai/Kwale, delta	480	Thermal	2006	
25	Chevron JV, Agura, Igbini, Lagos	750	Thermal		
26	Total Fina, Obite, Rivers	500	Thermal		
27	Exxon Mobil, Bonny, Rivers	500	Thermal		
	Sub total	4070			
	Grand total	12,745			

FEATURES OF THE NIGERIAN ELECTRICITY INDUSTRY

The features of the Nigerian Electricity Industry can be summarized as follows [10]:

1. Generates at 11kV and 16kV, transmits at 132kV and 330kV, and distributes at 33kV, 11kV, and 0.415kV.
2. Total installed capacity of approximately 7060MW.
3. The generating capacities consist of 29% hydro power and 71% thermal power.
4. Available generating capacity varies between 2500MW – 4000MW from 7 major host power stations (3 hydro and 4 thermal) and 2no IPPs.
5. The company now is made of eighteen companies. This include: six generating companies (GENCOs), eleven distribution companies (DISCOs), and one transmission company of Nigeria (TCN).
6. Customer population is approximately 5.0 million.
7. Average monthly energy generation is approximately 1800.00GWhs.
8. Average monthly revenue collection is approximately N5.8 billion.
9. Customer load distribution:
 - Residential = 60%
 - Commercial = 24%
 - Industrial = 12%
 - Customer on special tariff class = 1.4%
 - Street lighting = 0.6%
 - Power export = 2%

THE ELECTRICITY CRISIS IN NIGERIA

Power failure in Nigeria is perhaps the easiest topic to treat. Every where you look and turn, there is 'darkness'.

Nigeria's energy consumption Statistics are frightening. According to the Federal office of statistics, about 62.5% of Nigerians are without electricity. While some States have more access to electricity, others barely have any. Lagos State, the commercial nerve of the nation enjoys 95.5% access, Edo 70.7%, Kwara 65.9, Oyo 61.7, Osun 61.5, and Ogun 59.0. Others have to make do with much less: Jigawa 2.6, Bayelsa 3.5, Taraba 4.3, Kebbi 6.3, Zamfara 11.4, Sokoto, the seat of caliphate 10.5, Rivers 18.2% respectively [11].

Presently the Nigerian National grid is weak leading to a number of collapses [12,13]. Table 2 is a summary of grid system disturbances from January 1995 to December 2004. According to the study conducted by one of the Manufacturers' Association of Nigeria (MAN) branch in Lagos, about 85 per cent of the members depend on standby generators, 50 per cent of them have more than four generating plants, 20 per cent do not use NEPA at all [14]. This situation is applicable to other parts of the countries even worse.

Covenant University, Ota, Nigeria has total installed electric power generating plant of about 5.85MVA from 13 diesel generating sets provided as backups. Enormous amount of money is spent to buy diesel to fuel generating sets for electricity supply during periods of power outage. A particular study revealed that

about N14.00 million was spent in a month to fuel these generating sets. This value excludes the cost of purchase of spares, oils, and maintenance [15].

The information and communication technology (ICT) sector of the Nigeria economy is not left out because erratic power supply is viewed as the bane of ICT growth. Poor electricity supply ranks highest among the problems facing stakeholders in the Information and Communication sector. Recently, the Association of Licensed Telecommunications Operators of Nigeria (ALTON) blamed the increasing poor quality of services of telecommunications operators in the country on the lack of adequate power supply. The lingering spate of epileptic power supply has caused MTN a Nigeria telecommunication company to spend over N12 billion on generator acquisitions alone. It has also necessitated the spending of N500 million monthly or a staggering N6 billion yearly on diesel. Worse still, more than N5 billion go into replacing items damaged by erratic power supply [16].

According to the International Monetary Fund (IMF), manufacturers in Nigeria lose between N26.50 and N28.50 per kWh to power outages. Also, power generated by manufacturers is at the cost of N35 per kWh, against the normal tariff of N8.50 per kWh. This leaves a shortfall of between N26.50 and N28.50 as added cost of production to manufacturers [17].

A recent survey by MAN on power supply by the Power Holding Company of Nigeria (PHCN) to industries in the first quarter of 2006 indicates that the average power outages increased from 13.3 hours daily in January to 14.5 hours in March 2006. As reported in [18], Nigeria has remained top importing country of

diesel generating sets (range 1 kVA to over 2 MVA) in Africa amounting to US\$86.60, 94.47, and 122.36 million dollars in 2002, 2003, and 2004 respectively. As can be seen in table 3 these represent 29.39%, 32.58%, and 35.49% respectively.

There is no doubt that the country is in an energy crisis and the need to increase generation and manage the existing capacity is imperative [19].

The above scenario informs the reform programme of the government in the power sector, as the Nigerian treasury cannot fund this hung financial requirement, thus the need to attract substantial private sector investment.

TABLE 2
Summary of annual grid system disturbances of the Nigerian Power System, January 1995 to December 2004[12, 13]

S/N	Year	Total No of Disturbances
1	2004	14
2	2003	13
3	2002	24
4	2001	16
5	2000	11
6	1999	9
7	1998	18
8	1997	20
9	1996	10
10	1995	11
11	Total	146

TABLE 3
Importing Countries of diesel generating Sets (1kVA – 2000kVA) [18]

S/N	Country	US \$ million		
		2002	2003	2004
1	Nigeria	86.60 (29.39%)	94.47 (32.58%)	122.36 (35.49%)
2	Egypt	49.93	22.98	40.51
3	Algeria	34.62	23.47	34.57
4	Guinea	3.59	4.93	22.63
5	Angola	15.91	21.66	17.51
6	Djibouti	1.94	7.63	12.77
7	Sudan	12.22	33.10	12.16
8	Congo	7.52	7.77	10.73
9	Libya	6.76	8.49	9.95
10	South Africa	8.96	5.90	8.38
11	Ghana	5.53	4.08	7.50
12	Morocco	6.27	8.89	7.31
13	Kenya	5.39	4.28	6.03
14	Senegal	20.71	5.24	4.90
15	Madagascar	0.92	2.93	4.84
16	Cameroon	6.90	23.78	4.22
17	Ethiopia	4.22	3.60	4.24
18	Tunisia	3.41	3.96	3.52
19	Tanzania	2.98	5.93	3.95
20	Cote d'Ivoire	1.99	2.64	3.41
21	Gabon	2.70	2.28	3.27
22	Total	294.63	290.00	344.76

Source: Export Statistics from EU, USA, and Japan

COST OF POWER OUTAGES

The costs of electric power outage to electric customers are enormous. Attempts have been made to quantify these costs but the estimates vary widely. A 2001 report from the Electric Power Research Institute (EPRI) states that power outages and problems with power quality cost the U.S. economy over \$119 billion per year [20]. Researches and other studies have shown that the cost of electricity failures on the Nigerian manufacturing sector is quiet high, as industries and firms incur huge costs on

the provision of expensive back – up to minimize the expected outage cost. The average costs of this back – up are about three times the cost of publicly supplied power [21].

Numerous impacts of power outages have been identified. Included among these impacts are [20]:

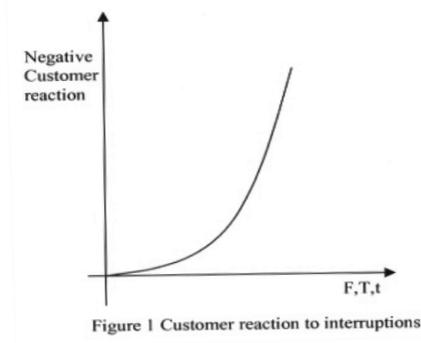
- ❖ Loss of life due to accidents (e.g., no street lights);
- ❖ Loss of life of ill and elderly (death rates go up);
- ❖ Loss of productivity by industry;
- ❖ Loss of sales by business;
- ❖ Loss of wages of labour;
- ❖ Damage to equipment in residential, commercial, and industry;
- ❖ Fires and explosions;
- ❖ Riots and thefts;
- ❖ Increased insurance rates; ❖ Loss of comfort.

Reliability of a system is difficult to measure. Perhaps the best way is through evaluation of the consequences of possible consumer interruptions. Investigations have shown that the best measure of reliability is that of consumer reaction.

Five conditions that have been identified impact the value an average consumer puts on an unsupplied kWh of lost energy:

1. the activities affected by the curtailment and therefore the time of the day and mix of customers;
2. the number of interruptions;
3. availability of advance warning;
4. weather conditions and therefore the time of year;
5. The duration of the interruption.

Figure 1 shows that this reaction increases dramatically as the frequency of outages increases, as the duration of the outage increases, and with the magnitude or extent of the outage.



The following function presents a means of evaluating this reaction:

$$R = \text{function of } \{K,F,P,t\}$$

1

Where K is an empirical coefficient proportional to the consumer's dependence on electricity; F is the frequency of interruptions; T is equal to duration of the interruptions; P is the amount of load interrupted, and t is the time when the interruption occurs.

Experience has shown that K increases with increasing consumption of electricity per customer, and is greatest at the time of the day, week, or year when people suffer the greatest hardships if service is interrupted. This criterion for reliability evaluation does not consider other curtailments of service, such as voltage or frequency reductions. These “partial” curtailments are not as important to most consumers as a complete

interruption but they are essential. Also, the duration of the interruption will be affected by the severity of the disturbance, the power system facilities affected, the redundancy or reserve built into the system, and the preparedness of the involved operating entities to respond. Some interruptions are of very short duration because the disturbance is transient and the system self corrects.

IMPACTS OF ELECTRICITY TO ACHIEVING THE NATIONAL GOALS

Like any other nation, Nigeria has a number of goals. Some of them include:

- The seven- point agenda of Mr. President, Alhaji Umaru Yar' Adua centred on: power and energy, food security, wealth creation, human capacity development, security of life and property, land reform, and mass transit.
- National Poverty Eradication Programme (NAPEP): aimed at poverty eradication.
- National Economic Empowerment Development Strategy (NEEDS -2), 2011: whose focus is poverty reduction through employment generation.
- Millennium Development Goals (MDGs), 2015: centred on poverty eradication and human development.
- Vision 2020: aimed at becoming one of the 20 largest economies in the world by GDP and by that, the financial hub of Africa.

It is pertinent to note that: sustainable, reliable, and affordable electricity services are indispensable to achieving these goals. Let us consider a few examples [22] – [24]:

Poverty Reduction and Wealth Creation

Energy is indispensable product to trigger and sustains economic growth, increase the availability and distribution of productive of capital, to increase the creation and productivity of enterprises, and increases employment and income. The strong correlation between economic growth and poverty reduction is well illustrated by the experience of such countries such as China, Vietnam and India, which have had sustained economic growth and a significant reduction in poverty.

It has been estimated by the World Bank that bringing energy cost to level of China would be equivalent to wage bill reduction of 25- 35% for countries such as Kenya, Nigeria and Zambia.

Access to reliable and affordable energy stimulates the creation of non farm home businesses. Modern energy enables the poor to benefit from modern communications, which help sound business decision making. Electricity provides an essential input into telecommunication, including simple telephone, radio, television and INTERNET.

Access to radio and television enhances information on local and national events. Reporting on weather can enhances information on local and events. Reporting on weather can enhances farmers and fishermen's ability to respond to sudden changes to reduce damages. Through telecommunications, farmers can also order inputs, market outputs, and keep track of prices for their products. Sustainable, reliable, and affordable electricity can free time for productivity activities. By switching to more efficient cooking

fuels the poor can significantly save on biomass fuel collection and cooking.

Access to light at night enables the poor to continue productive activities beyond daylight hours. Also, sustainable, reliable and affordable electricity enables the poor to benefit from the higher efficiencies of mechanized processes for both farm and non farm activities.

Powering pump sets and agro processing machinery enables farmers to irrigate, raise yield, and add value to crops.

Reduction of hunger and food Security

Sustainable, reliable, and affordable electricity services are needed to reduce hunger, and therefore to maintain human energy. About 95 per cent of the food are needed to be preserved especially during the harvest period. Without sustainable, reliable and affordable electricity most of the perishable food stuff get rotted and people cannot eat sufficiently to live healthy. On the economic front the frequent power failures lead a plunge in productivity in the industrial, commercial, and agricultural sectors. This in turn leads to an increase in prices of products and services to the public. Women will be the first to be affected, as they leave their share to their husband and children.

The empowerment of women has been acknowledged as an effective way to simulate sustainable development. Research has revealed that for every 100 household connected to the grid, some 10 to 20 new economic activities could potentially be created in the form of shops and small ventures.

Health

Electricity services are needed to improve health services: lighting and power are needed to improve safe child delivery and save mother's lives. Electric light at night reduce house accidents such as paraffin burns associated with other commonly used fuels. By powering equipment for health clinics energy enable health clinics to refrigerate vaccines, operate medical equipment, and provide treatment in the evening. By allowing the use of modern tools of mass communication for health education, energy helps the fighting of HIV/AIDS and other preventable diseases. Energy services are needed to draw safe water or boil water, and save the lives of children subject to diarrhoea.

Education and human capital Development

Energy resources are needed to build human capital, to provide education and training. Electricity can free time for education. Power to draw well water and to grind food products saves children's time, especially girls, to perform the household activities. Electric light in schools and homes extend the time available to study. In Energy Sector Management Assistance Program (ESMAP) case study of the Philippines on the impact of lighting on education. It was found that children from electrified households were one or two years ahead in their educational achievements as compared to children from non electrified households. Another ESMAP survey of women's time in rural India shows that probability that a woman will read is strongly related to the presence or absence of electricity in the home. Educated adult, especially women further ensure educated children. Research by the World Bank has shown that education for girls is the single most effective way to tackling poverty.

Women with even a few years of basic education have smaller, healthier families. Each additional year of female education is thought to reduce child mortality by 5-10%. Lighting and power helps retain teachers by improving the quality of life in rural areas. Availability of electricity increases access to electronic educational facilities, both for teachers and children, and to libraries.

Improvement of GDP and Security of life and Properties

The Gross Domestic product (GDP) is a measure of the value of goods and services produced by the country. It is an indicator of the economic growth of the economy. It is very important to note that small and medium scale enterprises (SMSEs) play significant role in poverty reduction, employment generation across the globe. Statistics attest to this fact. The SMSEs account for about 30 per cent of the global GDP and 58 per cent of the world's working population.

In the European Union countries, for instance, SMSEs constitute 99 per cent of all firms and employs 65 million people. SMSEs account for over 95 per cent of enterprises and 60 – 70 per cent of employment in the Organization for Economic Cooperation and Development (OECD) countries. SMSEs also account for about 60 per cent of the workforce and 25 per cent of the industrial output in Africa today.

In Nigeria, these enterprises constitute the majority – with all the imperfections in the system – and accounts for about 55 per cent of the total employment and about 50 per cent of the industrial output.

As can be seen from the above statistics, SMSEs constitute major avenue for gainful employment for people. This is primary because of the labour intensive nature of their production processes.

SMSEs also assist in simulating indigenous entrepreneurship and technology. They serve as vehicles for the propagation and diffusion of innovative ideas. SMSEs rely on local raw materials. This therefore triggers economic activities in those sectors that produce such raw materials.

Sustainable, reliable, and affordable electricity improves the investment climate for foreign and domestic business which leads to more employment. According to recent investment climate surveys, 48% of Sub Sahara Africa entrepreneurs' identify unreliable power supply as one of the major obstacles to the growth of their businesses.

It is believed that the unemployment situation in the country today will be halved within a few years if we get adequate and reliable electricity. The small and medium scale enterprises (SMSEs) such as the paper grinder, the tailor, the welder, the machinist, the spray painter, the baker, the carpenter, the furniture maker, cottage industrialists, etc can only survive when there is constant and dependable electricity supply.

These go a long way in improving the security situation in the country as youth are gainfully employed.

ELECTRICITY CONSUMPTION – GLOBAL TREND VS NIGERIA'S POSITION

The World Bank Human Development Report 2003 reviewed the per capita electricity consumption of 176 countries for 1980 and 2002. In that report Norway ranked first with a per capita consumption of 18,289 kWh in 1980. The per capita consumption for United States and United Kingdom were 8,914 kWh and 4,160 kWh respectively in 1980. The Nigeria's position was 92nd with 68 kWh.

In 2000 Norway relinquished the first position to Iceland with a consumption of 24,779 kWh. Ethiopia secured the last position (123rd) with 22kWh consumption and Nigeria's position has worsened to 114th with a consumption of 81 kWh. The review period witnessed a maximum increase in consumption of 773% by Indonesia. Republic of Korea and Bangladesh followed with 553% and 500% respectively. Nigeria had 19% increases. Whilst most of the world witnessed a 20 – year development in the review period, Nigeria essentially had one year (1999 – 2000).

A summary of the per capita electricity consumption (in kWh) for some countries are shown in Table 4 [4].

TABLE 4
Average Electricity per capita consumption (kWh) classified [4]

S/N	Classification	1980	2000
A			
1	Developed Countries	318	810
2	Least developed countries	59	77
3	Arab States	518	1,406
4	East Asia and the Pacific	253	918
5	Latin America and the Caribbean	845	1,528
6	South Asia	132	376
7	Sub – Saharan Africa	463	457
8	Central and Eastern Europe and CIS		2,977
9	OECD(Organization of Economic cooperation and Development)	4,916	7,336
10	High income OECD	5,687	8,688
B	Level of Human Development		
11	High human development	4,871	7,245
12	Medium human development	322	939
13	Low human development	116	162
C	Level of income		
14	High income	5,637	8,651
15	Medium income	578	1,391
16	Low income	106	352

Source: The World Bank Human Development Report, 2003.

TABLE 5
Electricity Generation, Consumption and GDP [9]

S/N	Country	Population (in million)	Power Generating Capacity (MW)	Per Capita Power Capacity (Watts per person)	Per Capita Consumption Per Person Per Year	Country's GDP ($\times 10^9$)
1	USA	293.6	848,300 (Year 2002)	2889.30	12,465.94	11,750
2	Germany	82.6	115000 (Year 2002)	1,392.25	6209.40	2,362
3	United Kingdom (England & Wales)	59.7	76,300 (Year 2001)	1,265.90	5742.50	1,782
4	South Africa	42.7	44650 (Year 2001)	1,045.67	4243.60	491.4
5	Brasil	179.1	86020	480.30		1,492
6	China	1300.1	338,300 (Year 2002)	260.00	1120.30	7,262
7	India	1086	115,520 ¹⁴	106.31	582.00	3,319
8	Ghana	20.7	1762	85.12	334.26	48.27
9	Nigeria	140.0	4000 (Year 2001)	28.571		125.7

As far as electricity generation and distribution business is concerned, Nigeria can not fully fit in the group of South Africa, Brazil, India, Singapore, and China. It can also not be said to be

an under developed economy because of its numerous potentials [9]. Table 5 is the electricity generating and consumption capacities of some developed countries, developing countries and Nigeria's position.

A look at Table 4 points to the fact that the availability of electricity for any country determines how and what the citizens engage in, what type of industries and commercial activity they can partake in and what their standard of living will be, etc.

The present 30 watts per person is certainly too small to light a lamp bulb for an individual. The 4000MW also serves the Niger republic which is connected to our grid. For us to be like South Africa now (with 1045.67W/person), not in the year 2020, we need a generating capacity of at least 146,394MW.

PROJECTED ELECTRICITY DEMAND FOR NIGERIA

The Energy Commission of Nigeria (ECN) has projected the electricity demand for Nigeria till the year 2030. As shown in Table 6 at a conservative growth of 7% Nigerian demand will amount to 50,820MW by 2020. Based on the estimate the Nation need installed capacity in excess of 60,000MW including *spinning reserve*. Does Nigeria have the inherent strength, political will and resources to join the league of top 20 economies by 2020? The federal government of Nigeria has spent between US\$10 billion and US\$16 billion to revamp the power sector from 1999 to 2007. In spite of this huge sum of money, Nigeria, with a population of over 140 million produces about 30 Watts of electricity per person while South Africa with a population of about 42.7 million produces 1045.67 Watts of electricity per person. For us to be like South Africa we require a capacity of

146,394 MW. This has indicated that even the 70,760 MW been projected by the year 2020 will only reduce the problem but will not be fully adequate for our needs.

TABLE 6
Projected Electricity Demand [25]

S/N	Scenario	Demand (MW)				
		2010	2015	2020	2025	2030
1	Reference (7%)	15,730	28,360	50,820	77,450	119,200
2	High reference (10%)	15,920	30,210	58,180	107,220	192,000
3	Optimistic reference(11.5)	16,000	31,240	70,760	137,370	250,000

Source: Energy Commission of Nigeria (2006)

THE COST OF ELECTRICITY INFRASTRUCTURE DEVELOPMENT

Three distinct levels of physical infrastructure are needed in the delivery of electricity to the consumer. These are generation, transmission and distribution. For the purposes of this evaluation the thermal power plants shall be considered. The cost of power plants built by the PHCN ranges from US\$400 to US\$500 per kW. Financing arrangement can result in costs in excess of this range. An average cost of US\$450 per kW is assumed.

The transmission network consists of two voltage levels of 330kV and 132 kV. Estimates from some 20 recent transmission grid development projects put the average costs per kW of new 330kV and 132kV transmission infrastructure at US\$295 and US\$140 respectively – 0.85 power factor assumed. Average cost of substation reinforcements obtained from 26 projects executed from 2000 is US\$22/kW for 132kV. For 330kV transmission level, the average value is US\$118/kW. We will assume that reinforcement will contribute 50 per cent of transmission capability in the near future and which then evaluates at

US\$287.5/kW of transmission capability – diversity factor between 330 kV and 132 kV transmission level of unity considered.

To arrive at the distribution infrastructure costs, average length of 33kV and 11/0.415kV distribution network of 50km and 25km respectively are assumed, with four 11kV feeders per 2 x 15MVA, 33/11kV injection substation. On this basis and employing current projection prices, the average cost per kW of 33kV and 11/0.415kV distribution network are US\$81 and US189 respectively. This evaluation utilizes the installed ratio of 33/11kV capacity to 11/0.415kV capacity 0.88.

The electricity infrastructure development cost/kW in Nigeria is therefore US\$1007.50 as scheduled in Table 7.

TABLE 7
Cost of Electricity Infrastructure [4]

S/N	Infrastructure	Cost/kW	Applied cost/kW
1	Generation	450.00	450.00
2	330kV transmission	295.00	287.50
3	132kV transmission	140.00	
4	330kV substation transmission reinforcement	118.00	
5	132kV substation transmission reinforcement	22.00	
6	33kV distribution	81.00	81.00
7	11/0.415kV distribution	189.00	189.00
8	Total		1007.50

From the above presentations, it can be seen that the cost of electricity infrastructure development is capital intensive. For us to generate the target of 6000MW in 18 months' time and 1700MW in 2011 by the projection of the present administration, we must invest a minimum of $(3000 \times 10^3 \text{ kW} \times \text{US\$}1007.5 =$

US\$3.0225 x 10⁹) US\$3.0225 Billion and (14000 x 10³kW x US\$1007.5 = US\$1.4105 x 10¹⁰) US\$14.105 Billion in excess of our present generating capacity which has not exceeded 3000MW. Also, for us to generate and meet our projected demand of 50,820MW by 2020 at a conservative growth rate of 7 per cent as depicted in Table 6, we need to spend about (47820 x 10³kW x US\$1007.5 = US\$4.818 x 10¹⁰) US\$48.18 Billion. For to be like South Africa now, we need a generating capacity of at least 146,394MW which will amount to at least (146394 x 10³kW x US\$1007.5 = US\$1.4749 x 10¹¹) US\$147.49 Billion. The analysis is based on the thermal power plants. These amounts will be higher considering that hydro power plants will be constructed along. It should be stated here that the analysis excludes fueling, maintenance, etc. associated with power plant use. Again, the financial arrangement can result in costs in excess of this range.

THE FUNDING OF THE NIGERIA POWER SECTOR

The Government funding of the power sector has not been remarkable. There was little or no investment in the power infrastructure for almost two decades between 1979 and 1999. No new power facilities were built and the existing ones were abandoned or at best poorly maintained. This has led to several infrastructures decay. The last power station was commissioned in 1990.

The Nigerian Press has in recent times given so much publicity to the level of funding in the power sector in the past eight years. There are conflicting reports that between US\$10 billion and US\$16 billion has been spent by the last civilian administration of President Olusegun Obasanjo. Yet, the Nigeria's energy

insufficiency and insecurity has persisted. This reveals the level of decay in the power sector.

In the recent public hearing on the multi – billion dollar energy probe by the House of Representatives Committee on Power [26], it was revealed that the total money spent by the Federal Government of Nigeria on power sector between 1999 and 2007 was about \$13.27 billion. The breakdown of the amount appropriated by the National Assembly (NA) is shown in Table 8.

TABLE 8
Amount Appropriated by the National Assembly (NA) between 1999 and 2007 [26]

S/No	Year	Amount Appropriated By the National Assembly (Billion Naira)
1	1999	6.697
2	2000	49.78
3	2001	70.971
4	2002	41.692
5	2003	50.270
6	2004	54.210
7	2005	70.131
8	2006	72.393
9	2007	61.161
10	Total	477.305

Source: Newswatch, Match 24, 2008, Pp. 44 – 46.

This was in addition to N235.5 billion, \$6.464 billion, Euro 33.037 million, and \$464 million loan from the World Bank, all expended on the National Integrated Power Projects (NIPP).

SHORTCOMINGS

The Nigerian power system (NPS) is faced with a lot of challenges. Some of these challenges include the following [3, 12]:

- * Over – dependence on generators to absorb reactive power MVars.
- * Weak system inertia.
- * Inadequate spinning reserves.
- * Poor turbine governor response.
- * Poor generator AVR response.
- * Long transmission and distribution lines.

These make voltage control difficult. These extra high voltage long transmission lines experienced the following operating problems:

- * Since the voltage profile along the line is dependent to a large degree on the loading conditions, sudden load rejection and line energisation have the effect of raising the voltage at the end of the line to dangerously high level,
- * An increase in length reduces the maximum power transfer capability of the line, thereby reducing the margin between the planned power transfer and the maximum limit at which the line is susceptible to transient and dynamic instability.

Restoration of power supply to the National grid after major system disturbances is often delayed because of the necessity to ensure that adequate reactors are in circuit and enough units have been synchronized to compensate the reactive Mvars generated by long transmission lines before switching, otherwise the resultant over voltage could damage terminal equipment at substations and power stations.

- * High transmission and distribution losses. The system losses averaged about 40% per annum. High system losses are undesirable. Besides their negative effects

on the quality and performance of supply, investment must be made in facilities and operations to supply losses. In a well run power system losses are approximately 9%. Of that, up to 7% can be lost through the transmission system. Table 9 shows the comparison of electricity consumption and percentage losses for some selected countries of the world.

TABLE 8
1998 power systems consumption, % transmission and distribution losses for some selected countries of the world

S/No	Country	Electricity consumption per Capita per kWh	% trans. and dist. Loss
1	Algeria	563	19
2	Benin	46	71
3	Egypt	861	12
4	Ghana	289	1
5	Nigeria	85	32
6	Brazil	193	17
7	India	384	18
8	Austria	6175	9
9	Germany	5681	4
10	Norway	24607	8
11	UK	5327	8
12	USA	11832	7

- * Limited transmission and distribution infrastructures. The long transmission lines during light load conditions give rise to reactive MVars. The NPS lacks adequate reactors to absorb reactive MVars generated by these long lines. The resultant effect is the overdependence on generators to absorb reactive MVars. This is not a healthy situation as the stability

margin of these machines are reached in this mode of operation.

- * Few Mesh network.

One of the determinants of a power system's reliability index is the available number of alternate routes of powerflow from a power station of the grid to another. The structure of national grid is weak due to the existence of several single long radial transmission lines with very few meshes or duplicated lines, thus constituting a single risk. A forced outage of this single circuit or route contingency usually triggers disturbance where the grid is split up. One portion of the split has insufficient generations; the other

has more than enough. This situation may result in a collapse of one or both portions of the grid if the magnitude of interrupted power transfer on the outage route was high. Switching out line jeopardizes system security significantly.

- * Lack of Automatic Static Var Compensators.

There are at present complete absence of fast acting static Var compensators(SVCs) to automatically compensate reactive power flow as may be required for voltage regulation during peak load, light or system disturbances. A common feature of the present control actions relates to the fact that the bus voltage is strongly related to the reactive power injection at the bus and either the control feature is not available or is too slow.

- * Inadequately Equipped National Control Centre (NCC).

Absence of a well-equipped National Control Centre (NCC) to facilitate quick monitoring of reactive power flow and

voltage at each node of the National grid. The National Control Centre at Osogbo is equipped with an analogue type SCADA (Supervisory Control and Data Acquisition) facility which has never really functioned properly. This was caused by a number of factors that were not appropriately addressed at the inception of the programme. These include:

- i. the absence of interface wiring between the switchgear and other installations at the various stations supposed to be monitored and the SCADA equipment.
 - ii. wrong transformation ratios specified for many of the transducers used in the SCADA system.
 - iii. a combination of a lack of understanding of how the installation works and the absence of a dedicated maintenance crew for such a gigantic installation.
- iv. some major generating stations and switching stations have not yet been incorporated into the system.

System operators at the NCC, however, depend on the following for system operation:

- I. Power line carrier (PLC) based PAX switched Telephone and unswitched power line telephone system (PLS) network linking all power stations and most 330kV substations.
- ii. A PLC based Telex network linking all power stations and most of the 330kV substations.
- iii. A 330kV voltmeter showing the voltage at the adjoining Osogbo 330kV transmission station.
- iv. Two digital frequency meters.

- v. An under frequency alarm relay set at 49.4Hz to alert control room operators to under-frequency conditions.

The above mentioned points constitute grossly inadequate SCADA facilities with which the Nigerian Electric System is currently operated.

- * Vandalism and theft. Electric installations are frequently been vandalized in Nigeria. The consequences include:
loss of man – hour, loss of revenue, and loss of fund.
- * Illegal connections.
- * Poor maintenance of transmission and distribution networks.
- * Poor communication system network.
- * Absence of the state – of – the – art dispatch facilities for merit order dispatch.
- * Bureaucracy.
- * Accidents and environmental problems.

During the dry season farmers and cattle rearers set fire to the bush under transmission lines. The resulting thick smoke causes flashover between the towers and the phase conductors on the 330kV transmission lines, which leads to forced outages. The transmission lines which experienced forced outages resulting from this include: Osogbo – Jebba – Kainji – Birnin Kebbi, Jebba – Shiroro - Kaduna, and the Kaduna – Jos 330kV lines.

- * Insufficient number of power injection points.
- * Limitation of existing substations (Capacity limitation).
- * Poor power allocation occasioned by drop in generation capacity.

- *Lack of industries and insufficient equipment maintenance centres.
- * Inefficient method of evaluating outages.
- * The use of non – automated protective devices.
- *Non-conformance to standard in project implementation.

THE POWER SECTOR REFORM

The non performance of NEPA led to the need for restructuring of the power industry to relieve it of the burden of inefficiency and thus create an environment where reliable, stable, and long – term electricity supply can be guaranteed amongst other perceived benefits.

It is near impossible for government alone to fund the necessary growth in the power sector in any country and in spite of the unprecedented allocation of funds to NEPA since 1999, the modest improvements that were noticed in the quality of power supply left the Authority with an excruciating debt of N21.653 billion to her bankers and a huge unfulfilled commitment of more than N138.4 billion to her contractors. As a way of rapidly mobilizing private capital and efficiency to the power sector the government has chosen the only option to embark on a privatization programme that aims at having at least 85% of the power sector privatized by year 2010 [12].

The road to privatization has been long and NEPA lost its monopoly over the operation of the Nigerian power system in 1998 when the National Council on Privatisation (NCP) empowered a 23 – member Electric Sector Reform Implementation Committee (EPIC) to develop recommendations

to promote the policy goals of total liberalization, competition and private sector led growth of electricity sector. The EPIC set out the Electric Power Policy statement which is to ensure that: Nigeria has an Electric Power Industry (EPI) that can meet the needs of its citizens in the 21st century and predicted that fundamental reforms at all levels are imminent [29].

The Electric Power Sector Reform (EPSR) was perfected in a bill signed into law on 11th March 2005 by the President and Commander – in Chief of the Federal Republic of Nigeria. Act 2005 gives legal authority and support to the reform activities, which is, restructuring and eventual privatization of NEPA.

The key provisions of the EPSR Act 2005 include the following [28]:

- * Creation of initial holding company, called Power Holding Company of Nigeria (PHCN) to take over the functions, assets, liabilities, and staff of the National Electric Power Authority (NEPA).
- * Unbundling of Power Holding Company of Nigeria (PHCN) into successor companies and ensuring greater operational autonomy, market development, privatization of successor companies.
- * Development of competitive electricity markets.
- * Establishment of the Nigerian Electricity Regulatory Commission (NERC).
- * Provision for licensing and regulation of generation, transmission, distribution and supply of electricity.
- * Enforcement of matters such as performance standards, consumer rights, and obligations.

- * Provision for the determination of tariffs and also matters incidentals and connected with all foregoing.

The main ingredients of the reform are deregulation, commercialization, privatization, free market evolution, etc [21]. It is aimed at improving the overall industry efficiency through restructuring, private sector participation, and competition which is a major driver of the industry's efficiency, through improved customer satisfaction and reduced tariff.

The implementation of the power reform bill kicked off with the incorporation of the initial holding company, called Power Holding Company of Nigeria (PHCN) on the 31st of May, 2005. The Nigerian Electricity Regulatory Commission (NERC) was officially inaugurated on October 31, 2005. The establishment of NERC is one of the main pillar of ensuring the delivery of an efficient power sector in Nigeria. The duties of NERC include:

- * To regulate tariffs and quality of service (to the extent proposed in the market design) and powers to oversee the industry effectively.
- * Monitor anti - competitive behaviour, including mergers and acquisitions involving licensed electricity companies.
- * Institutional and enforcement requirements of the regulatory regime.
- * Requirement for licensing by the NERC of the Generation Companies, System Operators, Transmission Services, Distribution Companies and Trading Companies that will be created from the restructuring and unbundling of NEPA.
- * Legislative Authority to include special conditions in licenses.
- * Provisions relating to public policy interests in relation to fuel supply, environmental laws, energy conservation,

management of scarce natural resources, promotion of efficient energy, promotion of renewables and publication of reports and statistics, etc.

- * Provisions contemplating the establishment of a Power Consumer Assistance Fund from which designated consumers shall enjoy some element of subsidies.
- * The establishment of the Rural Electrification Fund, to promote rural electrification through both public and private sector activities,
- * Providing a legal basis with necessary enabling provisions for establishing, changing, enforcing and regulating technical rules, market rules and standards.

As a result of the reform, the public sector monopoly enjoyed by the deformed National Electric Power Authority (NEPA) has been broken and the emerging Power Holding Company of Nigeria (PHCN) split into eighteen companies in what industry experts called '6 – 1 – 11 model' [29]. The companies have been licensed to operate and are registered with the Corporate Affairs Commission (CAC). The companies include: six generating companies (GENCOs), eleven distribution companies (DISCOs), and one transmission company (TCN). At the moment, there are IPPs generating electricity and selling to the power pool from which the eleven distribution companies' purchase as retailers through the power purchase agreement (PPA) [9]. Also as can be seen in Table 1 above, a number of NIPP and IPP projects are currently being constructed.

ATTAINING WORLD CLASS STATUS

It is no longer news that Nigeria aspires to become one of the 20 largest economies of the world by 2020. This is a very tall

ambition considering where we are at present. Tables 4 and 5 reveal our electricity generation, consumption per capita and GDP. In addition to the above, the following analysis will justify our ambition.

India has a population of about 1.1 billion inhabitants. It is presently the 12th largest economy in the world with a GDP of \$1.0 trillion and also the second largest growing economy in the world with a GDP growth rate of 9.4 per cent and a per capita income of \$3,800. In terms of production output, India is 14th in the world, as manufacturing accounts for 27.6 per cent of GDP and employs 17 per cent of its total work force.

Another country in this same race with Nigeria is China, which with a GDP of \$2.68 trillion, is currently the world's 4th largest economy. China has a population of 1.3 billion people, per capita GDP of \$2,000 and ranks third in the world in terms of factory output. Interestingly, by 1980, up to 80 per cent of China's population lived under \$1 per day, but that number has presently been reduced to less than 20 per cent.

The case of Malaysia is also worthy of note. Malaysia is presently the 34th largest economy in the world. With a population of 25.3 million people, it has a GDP of \$308.8 billion and a per capita income of \$12,800. Manufacturing accounts for 31.7 per cent of Malaysia's GDP.

Similarly, with a population of 245 million people Indonesia has a GDP of \$351.9 billion with an annual growth rate of 5.5 per cent and a per capita income of \$3,600. Manufacturing accounts for 28.1 per cent of Indonesia's GDP.

Nigeria on the other hand presently has a population slightly above 140 million inhabitants. Its GDP is \$107 billion with a per capita income of \$1,105. Nigeria's economy is growing at the rate 5.6 per cent, while manufacturing accounts for barely 4.81 per cent of its GDP.

From the foregoing, it is clear that for Nigeria to achieve the 20 – 2020 Vision, it must grow her economy by at least 13 per cent from the present 5.6 per cent every year consistently for the next 12 years [30].

From Tables 4 and 5 the Nigeria's electricity per capita consumption in 2000 qualifies her in the class of least developed countries and at the bottom for that matter. The average per capita consumption figure for 2003 is 147kWh based on 120 million populations. Even at this she remains at the bottom end of low income class or at the middle of low human development class.

To all intents and purposes the quest to rapidly attain the world class in terms of GDP is technically a function of adequate supply of electricity. We just need to increase the supply of electricity to an acceptable level not only to reduce the high cost of doing business, but also to improve other economic and domestic operations.

CHALLENGES

Notwithstanding the indispensability of regular power supply to national development, epileptic power supply remains the ugly reality in Nigeria. It is imperative at this juncture to x – ray some of the challenges confronting electricity infrastructure development in Nigeria. These include among others the following:

- * Uncertainty in continuity of energy policies due to absence of laid down electricity policy law. Nigeria had no viable and workable energy policy for many years. So attempts to improve Nigeria's energy situation were not guided by well – thought out blueprints. Therefore, the constant policy reversals witnessed in Nigeria cannot encourage investors. Investors will want to come in based on the economic policy and opportunities available in the country and they would want to invest money without knowing any body, without lobbying any body to ban and unban items, so that they can recoup their investment and make profits. The setting up of committees will not achieve anything. It is the policy that has been laid down, showing the power policy of Nigeria that will encourage investors to invest in the power sector.
- * Unfriendly community relations, which often disrupt gas and oil supplies to power plants. Cases of vandalization of oil and gas pipelines are rampant.
- * Existing gas sales and purchase agreement (SPAs) in the country do not favour local consumers. Government had already signed long term gas sales and purchase agreement up till 2011 to supply gas to the international markets. Thus, even if the IPPs and NIPPs are completed, they are likely to face gas supply shortages as the various SPAs focus on gas supply to internal markets.
- * Weak indigenous private sector, which is slowing down the effect of privatization of the sector. Today, power companies are in the hands of foreign investors. A case in point is the ceding of the management of the transmission

company of Nigeria (TCN) to an Indian firm, the Power Grid.

- * Unfriendly labour relations matters towards privatization of the energy sector.
- * Poverty and weak ability to pay for economic electricity tariffs and prices. The fact remains that the power distribution companies has been billing with very low tariff

for a unit of energy. Despite the NERC award of licenses to several private firms to build power plants, absolutely no investor has committed a farthing to the construction. This is because the private sector will not invest if the electricity tariffs are so low that there is no chance of cost recovery and profit making. Table 10 shows the tariff structure of Nigeria compared to some West African countries. This certainly has to change as no IPP will survive paying for competitive price of gas and other lubricants and spare parts with a tariff of N4 – N6/kWh.

TABLE 10
Tariff Structure for Electricity in some Countries

S/N	Country	Tariff (US cent/kWh)
1	Cote d'Ivoire	7
2	Togo	9
3	Senegal	11
4	Gambia	16
5	Nigeria	4

Source: Punch Saturday 15th July 2006

- * The completion of the National Integrated Power Projects (NIPPs) is now a mirage due to legal tussle and lack of fund. The Federal Government did not provide substantial funds for the power sector in this year budgets. However, the government ties the completion of the NIPPs solely to the excess crude oil account knowing full well there is a standing court injunction stopping such move. It should be recalled that the Revenue Mobilization Allocation and Fiscal Commission (RMAFC) obtained a court order stating clearly that revenue in excess crude account must be shared accordingly among the three tiers of government and not unilaterally withdrawn by the federal government for what reasons. The country is still heading to long hours of darkness. Recently, it has been reported that the State and the Local governments are clamouring for their share of the excess crude money.

- * Corruption as an impediment to development. Recent public hearing on the multi – billion dollar energy probe by the House of Representatives Committee on Power has revealed that a lot of money has been expedited without any appreciable improvement. This is because a lot of the money released has gone into the drain as a result of the 'kill and divide' syndrome of the undertakers of our electric power sector. A case in point is that of Laymeyer, a German company that collected the sum of N369 million as mobilization fees in 2005 to conduct feasibility studies on the multi billion naira Mambilla Hydro electric Power project. It will be interesting to hear that as at this presentation, the company has never even visited the project site. Rather, the company claimed that 'they were

faithful to the contract agreement blaming another company for failing to undertake the geo technical assessment for the project'. If no other thing, the probe has shown the level of decay and corruption in the power sector. How would people authorize expenditure and monies are paid to companies that would not deliver.

THE WAY FORWARD

It is now widely recognized and accepted that the Nigeria's power sector are grossly insufficient, inefficient and unsustainable to meet her national goals and position her to belong to the 20 – 2020. Therefore, the following suggestions are put forward [31] – [34]:

- * Review of existing information on the patterns of electricity
end – use in the residential sector and conduct additional surveys to determine how electricity is currently being used in the country.
- * Institutionalization of the National Energy Policy (NEP) and its master plans through Acts(s) of the National Assembly so as to facilitate reasonable continuity in energy policy.
- * Intensification of transparent privatization of the energy sector.

- * Appropriately arresting the unfriendly community relations so as to enable uninterrupted supply of energy services.
- * Strengthening of the private sector through provision of adequate incentives and development funds.
- * Adequate funding of the energy sector reforms to arrest unfriendly labour relations matters.
- * Strengthening of bilateral and regional cooperation to facilitate hydro power and other energy resources development.
- * Intensification of local research and development into problems of exploitation, generation, transmission and distribution of energy.
- * The importation of the generators should be banned. Government should make the use of generators an offence so that necessity will usher in invention.
- * Any private or corporate body wishing to invest in the industry should be allowed free duty importation of their equipment and some years tax holiday to recoup their investment.
- * Local contents initiatives. At present, the power sector has high foreign content in excess of 75 per cent. This means that huge opportunities exist for local manufacturers. A deliberate Government policy formulation aimed at establishing local manufacturing base from this

opportunity will be a welcome development. The local production will go a long way towards ensuring the long term sustainability of the sector.

- * Energy users can assist in arresting the situation through the use of energy saver lamps that have rating of 5W, 15W, and 20W instead of the bulbs we currently use which are of about 60W and 100W. These energy saver lamps give same or better illumination, last longer and do not emit heat energy as the incandescent lamps. Tables 11 and 12 attest to the benefits accruing from the use of energy saving lamps in domestic, commercial and industrial sectors.

TABLE 11
Energy Savings by the use of High Efficacy Lamps

S/N	Sector	Lamp Types		Power saving	
		Existing	Proposed	Watts	%
1	Domestic/Commercial	GLS 100W	*CFL 25W	75	75
2	Industrial	GLS 13W	*CFL 9W	4	31
		GLS 200W	Blended	40	20
		TL 40W	160W TLD 36W	4	10
3	Industrial/Commercial	HIPMV 250W	HPSV 150W	100	37
		HPMV 400W	HPSV 250W	150	35

* Wattages of CFL includes energy consumption in ballasts

TABLE 12
Energy Saving potential by the use of High Efficiency Lamps for Street Lighting

S/N	Existing Lamps *			Replaced Units			Saving	
	Type	Watts	Lifespan	Type	Watts	Lifespan	Watts	%
1	GLS	200	1000	ML	160	5000	40	7
2	GLS	300	1000	ML	250	5000	50	17
3	TL	2 x 40	5000	TL	2 x 36	5000	8	6
4	HPMV	125	5000	HPSV	70	12000	25	44
5	HPMV	250	5000	HPSV	150	12000	100	40
6	HPMV	400	5000	HPSV	250	12000	150	38

- * Our Architects also needs to look at the possibility of designing energy efficient home that are powered by photo voltaic solar panels on their roof tops. Given the amount of sunshine that the country enjoys all year round, the use of solar energy would on the long run be cost effective energy option for Nigeria. The houses will be part of renewable energy initiative and will also help in achieving the desired objective of reducing greenhouse gas emission.
- * Again the culture of using electricity only when we need it should be emphasized. A conservative estimate for this wastage was put at a figure of about 400MW- 500MW on a good generation day. If the security lamps, air conditioners, water heaters can be put off when not needed this power can be used for economic growth. Always turn off your home appliances such as computer and monitor, TVs and DVD players, when not in use. These appliances in standby mode still use several watts of power.
- * The government should make the use of energy efficient appliances compulsory. This is the smartest way of

controlling green house gas emissions. The technology for making appliances that use less electricity – such as light bulbs, air conditioners and refrigerators – already exists but manufacturers don't make them available because there is no legal push. Voluntary is nice but if you want impact, it has to be mandatory. For instance, in 2009, it would be illegal and punishable by law for anyone to use the regular 60W bulbs in Australia since energy efficient alternatives are available.

- * Governments at all levels can also enforce laws on the use of energy efficient and energy conservation materials in buildings, such as double glazing on windows and solar water heaters. Although energy efficient appliances are more expensive, the extra cost is easily recovered from the lower electricity bills over the life time of the appliances. This can be achieved by reducing taxes and duties on energy saving devices so that they are more attractive to purchase than the inefficient ones.

- * There should be a shift to cleaner and environmental friendly sources of energy in order to preserve our natural resources to future generations. Attention should therefore be shifted to the development of solar energy and small hydro power projects for remote rural areas that cannot be connected to the national grid. Nigeria has 278 identified unexploited sites with small hydro power potentials, with total capacity of 734.2MW. These energy sources are renewable by virtue of their limitless nature. They are environmentally friendly as they are devoid of the following:

1. Emission of greenhouse gases- global warming.
 2. Emission of ozone depletion gases.
 3. Noise, smoke and general nuisance from domestic diesel generators right into our ears, faces and lungs.
- * Improved architectural design for buildings and the development and use of new building materials with reasonable specific heats for thermal stability might offer new options. Architects should recognize the need to design individual houses to take maximum advantage of the natural conditions of harmattan, dry and rainy seasons, day and night. The energy efficient housing design principles are based on the idea of using natural conditions to the best advantages and they encompass all the available techniques of creating a “healthy” interaction between indoor and outdoor climatic conditions in buildings. Therefore, energy efficient houses should recognize the following:
- a. Proper building orientation and symmetry. Building design should permit most of the spaces to be day lighted. Using day lighting reduces energy consumption by replacing electric light with natural light. Building designed for day lighting typically use 40% to 60% less electricity for lighting needs than do conventional buildings.
 - b. Provision of enough windows for cross ventilation. In very hot climates ventilation is very important. This will go a long way in reducing the use of air conditioners at homes and offices. Although sunlight and daylight are free and readily accessible, however, their use without causing glare and overheating can be difficult. Glare can

- be avoided by using window sills, louvers, reflective blinds, and other devices to light while reducing solar heat should be favoured.
- c. Selection of suitable building materials. The walls and floor act as thermal mass to store the heat gained. Therefore hollow blocks and bricks should be used as much as possible. The shape of a building is also important from an energy point of view. A tall, slender building has a high surface area to volume ratio. Ideally a building should be compact, with a low surface area to volume ratio, since the building's surface is the element through which the heat transfer occurs.
- * Adoption of various demand side management (DSM) and energy conservation measures (ECM). Nigeria drive for regular electricity supply, security and sufficiency must not be restricted to efforts to boost power supplies; it must realistically extend to demand management. We must embrace efficient energy utilization and energy conservation measures if we are to insulate our national economy and social life from power crisis. Demand side management and energy conservation measures are processes of managing the consumption of energy. These processes are designed to optimize the available and planned generation resources. It has been reported that a lot of energy is lost at the consumers' side of the grid (with each household wasting at least 100W at a time [total nation – wide = 400 - 500MW]. Demand side management and energy conservation measures therefore refer to actions taken on the customer's side of the meter to change the amount or timing of energy consumption. They offer solutions to problems such as: load

management, energy efficiency, strategic conservation, and related activities Consumers should be educated on the need and incentive to reduce their demand at peak times. Methods that the consumers can use to reduce energy consumption and wastages include the following:

1. Installing lighting control systems, in bathrooms, stores, and bedrooms. Lighting controls are devices for turning light on and off or for dimming them. The simplest type is standard snap switch or on – off switch. Presently majority of our lights are controlled by snap switches. This is the simplest and the most widely used form of controlling a light installation. Its initial investment is extremely low, but the resulting operational cost may be high. It does not provide the flexibility to control the lighting, where its required. There is the need to install lighting control systems such as are photocells, timers, occupancy sensors, and dimmers in bathrooms, stores, bedrooms and other not frequently used areas..
2. Street light Control. Street lighting accounts for more than 50% of all lighting loads. Of this value about 50% or more of the energy is wasted by absolute equipment, inadequate maintenance, or inefficient use. Saving lighting energy requires either reducing electricity consumed by the light source or reducing the length of time. The following light control systems can be adopted at the design stage:
 - i. Grouping of lighting system, to provide greater flexibility in lighting control. This could be achieved by mechanical or electronic time clocks.
 - ii. Installation of microprocessors based controllers. In this method the use of microprocessor/infrared controlled

dimming or switching circuits is employed. The lighting control can be obtained by using logic units located in the ceiling, which can take pre-programme commands and activate specified lighting circuits. Advanced lighting control system uses movement detectors or light sensors, to feed signals to the controllers.

- iii. Installation of “exclusive” transformer for lighting. Most of the problems faced by the street and open court lighting equipment and gears are due to voltage fluctuations. Hence, the lighting equipment has to be isolated from the power feeders. This provides a better voltage regulation for lighting. This will reduce the voltage related problems, which in turn increases the efficiency of the lighting system.
 - iv. Installation of servo stabilizer for lightening feeder. Whenever the installation of exclusive transformer for lighting is not economically attractive, servo stabilizer can be installed for the lighting feeders. This will provide stabilized voltage for the lighting equipment. The performance of years such as chokes, ballasts, will also be improved due to the stabilized voltage. This set up also provides the option to optimize the voltage level fed to the lighting feeder. In many plants, during the non-peak hours, the voltage levels are on the higher side. During this period, voltage can be optimized, without any significant drop in the illumination level.
- * Installing hot water control (HWC).

A typical HWC is rated at 3kW. Without control it will operate in a continuous cycle based on upper and lower thermostat settings, adding significantly to the household load. The hot water in cylinders can be made to operate by defined algorithm. The algorithm design dictates how and

when the HWC will function and in turn how the load profile will be affected. i.e. peak clipping, load shifting or strategic conservation. This type of control allows the heating of water cylinders to be directly controlled by the distribution cylinder load and the number of the MW saving can be quite considerable given the size of the water system operator. The magnitude of the MW saving can be quite considerable given the size of the water cylinder load and the number of consumers that have HWC.

- * Maintenance of lighting fixtures and house hood appliances. Maintenance is vital to lighting efficiency. Light levels decrease over time because of ageing lamps and dirt on fixtures, lamp, and room surfaces. Together, these factors can reduce the total illumination by 50% or more, while lights continue drawing full power. The following basic maintenance suggestions can help prevent this:
 - i. Clean fixtures, lamps, and lenses every 6 to 24 months by wiping off the dust. However, never clean an incandescent bulb while it is turned on. The water's cooling effect will shatter the hot bulb.
 - ii. Replace lenses if they appear yellow.
 - iii. Clean or re - paint small rooms every year and large rooms every 2 to 3 years. Dirt collects on surfaces which reduces the amount of light they reflect.
 - iv. Consider group relamping. Common lamps, especially incandescent and fluorescent lamps lose 20% to 30% of their light output over their service life. Many lighting experts recommend replacing all the lamps in a lighting system at once. This saves labour, keeps illumination high, and avoids stressing any ballast with dying lamps.

- v. Also make sure your heating and cooling systems are properly maintained. Check your owner's manuals for the recommended maintenance. Also, consider installing programmable thermostat that is compatible with your heating and cooling system. Heating and cooling systems account for a considerable household's energy consumption.
- * The introduction of pre – paid meter is another dimension to demand management that need to spread from few privileged urban centres to other parts of the country. This device ensures that people only pay for what they actually consumed rather than estimated consumption. Experience has shown that pre – paid meters make households conscious of their energy consumption and save cost.
- * Employing New Distribution Automation Technologies (DATs).

A number of distribution automation technologies are in place today and could be used to reduce energy wastages. A distribution automation technology or distribution management system (DMS) as it sometimes called is a system of computer-aided tools used by operators of electric distribution network to monitor, control, and optimize the performance of the distribution system.

The deployment of DATs will provide the following benefits:

- i. Enables management to take full control of their energy management operations, thus reducing costs.
- ii. Shift loads to off-peak periods.
- iii. Scheduling large loads to start at different times. By delaying the start of a large load for as little as 15 minutes, peak values will be reduced.

- iv. Peak shaving, involves reducing the entire energy load. The use of DATs will maximize use of efficient base load generation and reduce the need for spinning reserve.

CONCLUSIONS

To all intents and purposes the quest to rapidly attain the world class in terms of GDP is technically a function of adequate supply of electricity. We just need to increase the supply of electricity to an acceptable level not only to reduce the high cost of doing business, but also to improve other economic and domestic operations. The current level and pattern of Federal Government funding as well as electricity use, abuse, and misuse in the power sector of the economy will not take the country to the enviable height of becoming one of the world's 20 biggest economies by 2020.

It is well known fact that the engine room for industrial and economic growth as well as poverty alleviation for any nation is availability of good quality and affordable power. Access to adequate and affordable energy has serious correlation to the economic development and poverty alleviation.

As the Nigeria government geared towards actualizing the Vision 2020, there is the need to develop robust electricity infrastructures. This will give the majority of the other sectors leverage that could catapult the nation into a strong resilient economy. Electricity sufficiency and reliability is inimical to: adequate provision of health care, wealth creation, SMSEs to contribute meaningful to GDP growth, for poverty alleviation, security of life and property, human capital development, food security, etc.

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