ENERGY COMMISSION OF NIGERIA
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ENERGY IMPLICATIONS OF VISION 20: 2020 AND BEYOND

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CONTENT

ABBREVIATIONS

AGO	Automotive Gas Oil
ATK	Aviation Turbine Kerosene
BAU	Business as Usual
Bn	Billion
Boe	Barrels of Oil Equivalent
b/d	Barrel per Day
BPY	Barrels per Year
BSPD	Barrels per Stream Day
BTU	British Thermal Unit (energy unit)
CCGT	Combined Cycle Gas Turbine
CHP	Combined Heat and Power
CO_2	Carbon dioxide
^{O}C	Degrees Centigrade
EJ	Exajoule (= 10^{18} Joules)
GDP	Gross Domestic Product
GNP	Gross National Product
GT	Gas Turbine
GW	Giga Watt
GWe	Giga watt of electricity
h/d	Hour per Day
HDI	Human Development Index
HDR	Human Development Report
HHK	Household Kerosene
IAEA	International Atomic Energy Agency
IMF	International Monetary Fund
IPPs	Independent Power Plants
kg	Kilogram (thousand gram)
kgoe	Kilogram
km	Kilometer (thousand meter)
KRPC	Kaduna Refinery and Petrochemicals Complex
ktoe	Thousand tonnes of oil equivalent
$kW/m^2/day$	Thousand Watt per square meter per day
kWh/m^2	Thousand watt hour-square meter
kWyr	kilowatt per year
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
mb/d	million barrels per day
m/s	meters per second
M^3/y	Cubic meter per year
MAED	Model for Analysis of Energy Demand
MDGs	Millennium Development Goals
MESSAGE	Model for Energy Supply Strategy and their General Environmental Impacts
mm	Millimeter
MW	Mega watts

₦	Nigerian Naira (Nigerian unit of Currency)
N/A	Not Applicable
NG	Natural Gas
NIPPs	Nigerian Independent Power Plants
NPC	National Population Commission
NPRPC	Warri Refinery and Petrochemicals Complex
OPEC	Organization of Petroleum Exporting Countries
OPRPC	Old Port Harcourt Refinery and Petrochemical Complex
PMS	Premium Motor Spirit
PPP	Purchasing Power Parity
PV	Photo Voltaic
Ref.	Refinery
RMS	Regular Motor Spirit
$	United States Dollars
Scf/d	Standard Cubic Feet per Day
Sq	Square
Toe	Tonnes of Oil Equivalent
Tscf	Trillion Standard Cubic Feet
UNDP	United Nations Development Programme
Wh/cap	watt-hour per capita
Wh/m^2	watt-hour per square meter
WRPC	Warri Refinery and Petrochemicals Complex

CHAPTER ONE

1.0 INTRODUCTION

Nigerian government has set ambitious goals for its socio-economic development, developing a unified plan of action on all issues relating to repositioning Nigeria from its current position in the world's GDP ranking to be among the top 20 most developed countries of the world by year 2020. This development blueprint is tagged Vision:2020. As at 2010, the IMF's ranking of economies of countries of the world places Nigeria in the 31st position by GDP on Purchasing Power Parity (PPP) basis. To move to the group of first twenty by 2020, Nigeria needs to grow its economy at an average rate of 13.8% per annum (FGN, 2010) from the present growth rate of about 6%. The main thrust of the Vision, which is economy based, is to increase the GDP of the country to about US$900 billion and per capita income to US$4,000. The improvement in national and personal income is expected to translate into improvement in social aspects of the Vision, such as the Human Development Index (HDI).

Socio-economic development is driven by energy that powers the nation's industries, vehicles, homes and offices. Energy is central to sustainable development and poverty reduction efforts. It affects all aspects of development; social, economic, and environmental, including livelihoods, access to water, agricultural productivity, health, population levels, education, and gender-related issues. None of the Millennium Development Goals (MDGs) can be met without major improvement in the quality and quantity of energy services in Nigeria. UNDP's efforts in energy for sustainable development support the achievement of the MDGs, especially MDG 1, reducing by half the proportion of people living in poverty by 2015. Through an integrated development approach, UNDP works to help create enabling policy frameworks, develop local capacity and provide knowledge-based advisory services for expanding access to energy services for the poor (UNDP).

To energize the Vision 2020, the Blueprint planned to increase the electricity production of the country from 4,000MW in 2007 to 35,000MW in 2020 and the petroleum refining capacity from current 445,000 b/d to 750,000 b/d in 2015 and 1,500,000 b/d in 2020. The objective of this study is to evaluate the adequacy or otherwise of the electricity production and petroleum refining targets of the Vision and proffer suggestions as to the energy supply that may be adequate for the realization of the Vision.

The methodology adopted is to first evaluate the energy demand, using the Model for Analysis of Energy Demand (MAED) developed by the IAEA. The energy demand projections then served as input to the Model for Energy Supply Strategy and their General Environmental impacts (MESSAGE), also developed by the IAEA, to evaluate the supply strategies for meeting the energy demands.

Manufacturing and services sectors are expected to be the major drivers of the growth. Nigeria needs to significantly upgrade the quality and size of its energy infrastructure in ways that are environmentally and socially sustainable to power the achievement of the Vision. Sustainable energy supply must be available, accessible, affordable and reliable. The quality of energy services cannot be inferior to the equivalent services provided by the established system; rather it must have the potential of becoming significantly better. Supply densities must match demand densities.

Presently, the supply of modern energy, especially electricity, liquefied petroleum gas, kerosene and diesel is grossly inadequate and there is so much dependence on traditional fuels by the rural dwellers and the urban poor who account for about 60% of the population. Traditional fuels accounted for 55% of the total energy consumption. Energy-induced environmental degradation is already prevalent in the country. This is characterized by deforestation as a result of felling of trees for fuelwood, air pollution in urban areas arising from vehicular emissions and the burning of traditional fuels for cooking in households, noise and air pollution from use of small generators to provide electricity due to inadequate supply from the national grid, and land and water pollution from oil spillages in the oil producing communities. These impact negatively on the quality of life of the population, hence on the development aspirations. There are many inputs necessary for the realization of the Vision, of which energy is one. Several individuals and government agencies have commented on the energy requirements for Vision 2020.

The objective of this study is to carry out an evaluation that provides more insight into the subject and to help us visualize better the many-faceted reality of the energy situation in Nigeria, to provide the basis for decision – making and action. It provides insights into what needs to be done in the energy sector to provide adequate and reliable energy or guarantee security of energy supply in order to achieve the Vision: 2020.

The study employed the MAED to estimate energy demand for the Vision 2020 and three other possible development scenarios and the MESSAGE to explore strategies for the supply of projected energy demands for the development scenarios. Although the MAED and MESSAGE models were applied for projections up to 2040, the focus of the analysis is the period up 2020 because it should be of interest to the current political leadership of the country.

CHAPTER TWO

2.0 PAST AND PRESENT SOCIO-ECONOMIC AND ENERGY SITUATION IN NIGERIA

2.1 Geography and Climate:

Nigeria a tropical Sub-Saharan West African country, lies within latitudes 4^{o} 1´and 13^{o} 9´North of the Equator and longitudes 2^{o} 2’ and 14^{o} 30´East. It is bounded by Benin Republic, Niger, Chad and the Cameroon to the West, North, North East and East, respectively, and by the Atlantic Ocean to the South (Fig. 2.1) and occupies an area of 923,768 sq km. The vegetation is mangrove forests in the south, which is interspersed by a network of rivers and creeks. It transits to tropical rain forest further inland and progresses into a savannah region further north.

Fig. 2.1: Location Map of Nigeria

The climate in the southern areas is equatorial, with high humidity and rainfall. The coastal town of Port-Harcourt, for instance, has monthly minimum-maximum temperatures in the range of 18-36^{O}C over the year, relative humility at 9.00 am of 61-94% and at 3.00 pm of 30-86%. The average annual rainfall is about 1900 mm. The northern areas are semi-equatorial, with lower humidity and rainfall, for example Sokoto in the Northwest Region of Nigeria. The rainfall level demarcates the seasons into two, namely, the wet and dry seasons, for instance, with monthly minimum-maximum temperatures in the range of 13-41^{O}C over the year, relative humility at 9.00 am of 12-85% and at 3.00 pm of 7-68%. The wet season lasts over April to October, while the dry season lasts over November to March. However the coastal areas experience more rainy months while the extreme Northern parts have more dry months (IAEA/ECN 2008).

Solar radiation intensity varies from an annual average of 3.5 - 7.0 kWh/m^2-day, the annual average of daily sunshine hours varies from 4 - 9 hr/day. Wind speeds vary from 4.0 - 5.1m/s and 1.4 - 3.0 m/s in the north and south, respectively. The nation is blessed with a multitude of rivers. The overall hydropower potential is estimated at 15 GWe or 14,750MW. The coal reserves are 2.75 billion tonnes for inferred and 6.39 million for proven. Crude Oil reserved was estimated to be 4,500 million tonnes of oil equivalent (Mtoe), Tar Sand (30 billion barrels of oil equivalent), Natural Gas 4.5 trillion m^3 or 187 Tscf and preliminary investigations have since confirmed the availability of uranium in especially the north eastern region of the country but the magnitude of the reserve is yet to be quantified (Table 2.1).

Table 2.1: Nigeria Energy Resources

S/No	Resource Type	Reserves (Natural Units)	Utilization (2008)
1	Crude Oil	36.2 billion barrels	0.45mb/day
2	Natural Gas	187 Tscf (4.5Tm^3)	•59.1% - Fuel, Industries, re-injection and gas lift. •26.8% - gas flare
3	Coal and lignite	2.7 billion tonnes	Negligible
4	Tar sands	31 billion barrels of oil equivalent	0.224 million tones
5	Nuclear	Yet to be quantified	30kW
6	Large Hydropower	11,250 MW	1,972MW
7	Small Hydropower	3,500 MW	64.2MW
8	Solar	4.0 kW/m/day – 6.5 kW/m^2/day	•10MW solar PV stand-alone •No solar thermal electricity
9	Wind	2-4 m/s @ 10m height mainland	•2x2.5KW electricity generator •10MW wind farm contracted in2009
10	Biomass		

(i)	Fuelwood	11 million hectares of forest and woodland	43.4 million tonnes of fuel wood/year
(ii)	Animal waste	245 million assorted animals	
(iii)	Energy crops and agricultural residue	72 million hectares of agricultural land and all waste lands	

2.2 Demography

The population of Nigeria has grown from 134 million in the 2005 to 154 million in 2009. Approximately 48% of the population lives in the urban areas (Table 2.2), the total population growth rate is about 3.16% per annum (FGN-NPC, 2009). The working population as at 2009 was about 55.33 million, total salaried working population was 5 million representing about 18% of the working population. Agriculture had the highest working population (30 million) followed by services (21.73 million), manufacturing (1 million) and construction, energy and mining having less than 1 million (FGN-NPC, 2009).

Table 2.2: Development of Population

Parameters	**Unit**	**2005**	**2006**	**2007**	**2008**	**2009**
Total Population	10^6 Person	137.49	140.00	144.48	149.10	153.88
Population in Urban Areas	10^6 Person	65.99	67.2	69.35	71.57	73.86
Population in Rural Areas	10^6 Person	71.49	72.8	75.13	77.53	80.02
Potential Labour Force	10^6 Person	56.17	58.93	61.25	62.95	64.96
Actual Labour Force	10^6 Person	49.49	50.89	52.33	53.81	55.33
Labour Force in Service Sector	10^6 Person	19.22	19.76	20.32	21.01	21.73

There are about 32.06 million dwellings in the country with an average household size of 4.8 persons per dwelling. 55.2% of the dwellings are electrified. While 0.7% of the electrified dwellings use electricity for cooking, 20.7% use kerosene, 15.9% use gas and 1.6% use coal briquettes; the rest basically are rural dwellers and they use fuelwood for their cooking purposes (Table 2.3).

Table 2.3: Population Lifestyles

Parameters	Unit	Amount
Total Number of Dwellings	10^6 Dwellings	32.06
Average Household Size	Person / Dwelling	4.80
Electrified Dwellings	%	55.20
Dwellings with Hot Water Facility	%	100.00
Dwelling with Solar Installation	%	0.00
Households using FF for Lighting	%	62.17
Households using Electricity for Cooking 2009	%	0.70
Households using Kerosene for Cooking 2009	%	0.70
Households using Gas for Cooking 2009	%	22.90
Households using wood for Cooking 2009	%	74.10
Households using Coal for Cooking 2009	%	1.60

2.3 Macroeconomics

The Gross Domestic Product (GDP) and the percentage contributions of the various sectors of the economy over the last five years as from 2005 are shown in the Tables 2.4 and 2.5 Agriculture consistently contributed the largest share ranging between 41.01% and 42.07% to the GDP over the five-year period. Of the agricultural components, namely: crop production, livestock, forestry and fishing, crop production contributed more than 80% of the share for the whole five year period. The major crops were yams, cassava, maize, guinea corn, millet, beans and groundnuts.

Table 2.4: Sectoral GDP at Constant 1990 Basic Price (₦ million)

Sector	2005	2006	2007	2008	2009
Agriculture	231,463.6	248,598.95	266,477.30	283,913.00	299,996.90
Construction	8,544.5	9,654.79	10,912.60	12,337.50	13,851.14
Energy	136,345.5	151,309.47	146,441.90	141,448.50	138,792.36
Manufacturing	21,305.1	23,305.87	25,535.60	27,905.10	30,013.82
Mining	1510.8	1,665.96	1,878.30	2,118.10	2,374.03
Services	159,027.4	161,286.58	183,005.90	207,166.60	231,921.44
GDP	561,931.4	595,821.60	634,251.60	674,888.80	716,949.70

Table 2.5: Sectoral Share of Total GDP (%) at Constant 1990 Basic Prices

Sector	2005	2006	2007	2008	2009
Agriculture	41.19	41.73	42.01	42.07	41.84
Construction	1.52	1.62	1.72	1.83	1.93
Energy	27.85	25.39	23.09	20.96	19.36
Manufacturing	3.79	3.91	4.03	4.13	4.19
Mining	0.27	0.28	0.3	0.31	0.33
Services	25.38	27.07	28.85	30.7	32.35
Total	100	100	100	100	100

Agriculture is very closely followed by services sector including transport (25.38-32.35%), and energy sector (27.85-19.36%). The major contributors in the service sector were trade, government service and banking & insurance, in that order. Together, they accounted for 70-80% of GDP in the service sector. Although energy mining and energy services sector (11-14%) includes utilities, by far the dominant sub-sector was crude petroleum and gas. It accounted for over 95% of the sector's contribution to GDP. In 2008, oil and gas accounted for over 72% of income to the Federation Account and 95% of total export income. This level of dominance by oil and gas over the sector has been maintained over the years. Since 2001, the contribution of gas has been growing, very significantly, with the commencement of the production and export of liquefied natural gas.

The contribution of manufacturing to GDP was low, at about 3-4%. Of this, large scale industries accounted for over 85%. Construction and mining made the least contributions at about 2% and 0.3%, respectively. The fastest growing sector of the economy was manufacturing with an average growth of 8.84%, followed closely by construction (8.80%). The growth rates for agriculture and services were comparable at 6.10% and 5.2%, respectively. While agriculture, construction, mining, services and the total GDP (at constant 1990 factor cost) showed modest positive growth rates over 1991-2000, manufacturing and energy declined, with growth rate of -1.26% and –0.025%, respectively. Manufacturing, in particular, showed continued decline from 1991 to 1999, with a slight recovery in 2000. A major contributor to this poor performance of the manufacturing sector was the fall in actual electricity supply capacity during the same period.

Table 2.6: Energy and the Economy

Indicator	2003	2004	2005	2006	2007	2008
Real GDP Growth (%)	9.6	6.6	6.5	6	6.2	6.4
Major Contributors to GPD @ 1990 Constant Prices:						
Agriculture (%)	41.01	40.98	41.19	41.72	42.2	42.07
Crude Petroleum (%)	26.53	25.72	25.26	21.85	19.35	17.54
Major Contributor to						
Federal revenue (net)						
Crude Petroleum (%)	75	77	72.4	76.7	67.7	71.8
Energy Intensity (kgoe/$) (Energy Consumption/GDP)	0.244	0.186	0.157	0.086	0.063	0.069
GPD/Capita (US$)	620.9	673.2	847.4	1,036,2	1,256.60	1,176.10
Energy Consumption/Capita (kgoe/capita)	151.3	125.5	132.6	87.1	81.4	80.8
Electricity consumption/capita (kWh/capita)	174.6	176.4	181.4	167.6	161.2	142.9
Electricity Access (%)	55.2% from 40% in 1993					

The structure of the economy remained essentially the same over the period. The small gains by agriculture (2.9%), services (2.4%) and construction (0.2%) constituted losses by mining, energy (3.1%) and manufacturing (2.5%).

2.4 Indigenous Energy Resource Development

A. Crude Oil

Nigeria is an oil exporting country with significant reserve that ranks 6th in the world and is a member of Organization of Petroleum Exporting Countries (OPEC). The oil reserve is presently estimated at 36.2 billion barrels of oil (4500Mtoe), while the production capacity is about 3 million barrels/day (mb/d). The OPEC quota restricts actual production to around 2.5 – 2.8 mb/d. The long-term policy is to continue to increase the reserve base to the highest-level possible, and increase OPEC quota in consonance with increases in reserve base and productivity.

Most of the production is from on-shore fields in the Niger Delta Basin. There's significant production, however, in the shallow and deep offshore concessions. The greater part of new fields will come from the offshore areas of the basin. The policy strategy adopted by government for the development of the deepwater fields is to use Production Sharing Contracts and Sole Risk Arrangements.

B. Natural Gas

The natural gas reserve is 4.5 trillion m^3 (4090Mtoe or 167.8EJ), composed of 53.5% associated gas and 46.5% non-associated gas. Nigeria is ranked 7th in the world gas reserves. Gas utilization has remained far below production. Of the 5.8 billion m^3 produced in 2002, 47.8% was flared. It is planned that all gas utilization projects will be based on associated gas until the latter is fully committed. The exception is the existing Nigeria Liquefied Natural Gas project, which predominantly uses non-associated gas, though it is planned to progressively increase the utilization of associated gas.

A study of natural gas utilization in the country estimated a projected demand potential of about 201 million m^3 per day by 2010 and 297 million m^3 per day by 2020, for the combined domestic and export markets, and for field use. At these utilization rates, the reserve life spans will be 55 and 35 years, respectively, so that there should be no resource constraint. The domestic market will be composed mostly of power, cement, fertilizer, steel and other projects (aluminum, petrochemicals, manufacturing and distribution). By far the largest present domestic consumer, as well as source of future potential for domestic market expansion is the power sector.

The export market potentials are in liquefied natural gas (LNG), natural gas liquids (NGL), gas to liquid (GTL), pipeline gas, and gas-based chemicals projects. Already, the Joint Venture Nigeria LNG plant at Bonny now has six producing trains with the total capacity to 20.4 million tonnes per yr (27.35 billion m^3 per yr). Expansion to ten trains is envisaged in the future, while other two private sector LNG plants are being planned, one at Olokola and the other at Brass.

The West African Gas Pipeline project is underway. It involves a concession agreement by Nigeria, Benin Republic, Togo and Ghana to pipe Nigerian gas on an offshore route from the Lagos end of the Escravos-Lagos Gas Pipeline at Alagbado to Takoradi in Ghana, with spur lines at Benin, Togo, Tema (Ghana) and Takoradi. The line may be extended to the Ghana-Cote D'Ivoire border at Effasu and later to Senegal. The pipeline capacity is to be 620 million scf/d. Preliminary considerations are being given to Nigeria-Algeria Trans Sahara Gas Pipeline, which is destined for the European market.

C. Coal

The inferred and proven reserves of coal in the country are respectively 2.75 billion tonnes and 6.39 million tonnes. It occurs in 13 states and 17 mine sites. Of these, only four mine sites have been developed, namely, Okpara and Onyeama underground mines at Enugu, Okaba surface mine in Kogi State and Owukpa underground mine in Benue State. Nigerian coals are mostly bituminous, with medium to high calorific values and so are good for power generation and for thermal applications. They are also low in sulphur and ash content and thus have a high export potential. They are mostly non-coking but can be blended with imported coal for coking use, for instance in Ajaokuta Steel Plant. Some coking coal deposits exist, however, at Lafia-Obi in Nassarawa State.

Presently, local consumption of coal is low due to loss of the power and train locomotives markets to natural gas, hydro and diesel, and due to the run down state of its other major consumer, the Nkalagu Cement factory. Due to the new focus on developing the solid minerals sector, especially with foreign and domestic private sector capital, the coal market will be re-built. The National Programme on Alternatives to Fuelwood will establish a coal briquette plants as one of the strategies for fighting desertification and soil erosion. In all, the estimated domestic potential demand for coal is in excess of 600,000tonnes/yr, while the current consumption is only about 10,000tonnes/yr.

D. Tar Sands or Bitumen

Tar sands deposits exist in the southwest region of the country, in a belt 4.6km wide and 120km long, which runs from Edo, through Ondo and Ogun to Lagos States. It is reputed to be the second largest deposit in the world, second only to Venezuela's Dada field. At 31billion boe, the reserves are almost equal to the currently known crude oil reserves. Heavy oil for the production of bitumen or asphalt and other heavy oil fractions are obtained from the tar sands.

E. Hydro Power

Hydropower is derived from the potential energy available from water due to the height difference between its storage level and the tail-water to which it is discharged. The technical hydropower potential in Nigeria has been estimated at about 15GW, of which about 14% (1.9GW from Kainji, Jebba and Shiroro) was being utilized as at 2000 which represented some 30% of the total installed grid-connected electricity generation capacity of the country.

F. Solar Energy

Nigeria is blessed with solar radiation intensity, which varies from an annual average figure of 7.0kWh/m2 at the extreme north to 3.5kWh/m^2 in the extreme south. These figures are more than sufficient for both thermal and photovoltaic applications.

G. Biomass Energy

The biomass resources of Nigeria consist of wood, forage grasses and shrubs, animal wastes arising from forestry, agricultural, municipal and industrial activities as well as aquatic biomass. The primary way to utilize biomass is through direct combustion. Biomass is the leading source of energy for Nigeria contributing about 37% of the total energy demand. Nigeria's estimated biomass resources are 144 million tonnes per year. The country is presently consuming about 43million tonnes of fuelwood annually.

H. Wind Power

Wind resources can best be exploited where the wind power density is At least 400 W/m^2 at 30m above ground. Wind speeds in Nigeria vary considerably, with the extreme North having from 4.0 to 5.12m/s and 1.4 to 3.0m/s in the southern part of the country. Nigeria was a poor/moderate wind regime. It is also observed that the wind speeds in the country are generally weak in the south except for coastal regions and offshore.

I. Uranium

Uranium ore exist mostly in the northern part of the country. It is believed that it is the same deposits that extend to Niger Republic where French companies have been mining the ore. More is required to quantify the Nigerian uranium ore. The nation shall promote private sector participation in the electricity sub-sector, while ensuring broad-based participation of Nigerians

2.5 Energy Related Policies

The National Energy Policy is an overall energy policy document for the country, with which all other energy sub-sectoral policies must be compatible with and be derived there from. It was approved in 2003 and its 9-point objectives summarize the thrust of the policy and are as follows:

a. To achieve national energy security and efficiently provide for the nation's energy needs with a diversified and optimal energy mix ;
b. To guarantee increased contribution of energy production activities to national income;
c. To guarantee adequate, reliable and sustainable supply of energy at appropriate costs and in an environmentally friendly manner;
d. To guarantee efficient and cost effective consumption pattern of energy resources;
e. To accelerate the process of acquisition and diffusion of technology and managerial expertise in the energy sector and indigenous participation in energy sector industries, for stability and self-reliance;
f. To promote increased investments and development of the energy sector industries with substantial private sector participation;
g. To ensure a comprehensive, integrated and well-informed energy sector plans and programmes;
h. To foster international co-operation in energy trade and projects development in both the Africa region and the world at large;

i. To foster international co-operation in energy trade and projects development in both the Africa region and the world at large;
j. To successfully use the nation's abundant energy resources to promote international co-operation.

The policy document has provisions for the exploitation of all the nation's energy resources (oil, gas, tar sands, coal, uranium, hydropower, solar, biomass, wind, etc). It further provides for energy utilization issues namely, electricity, energy efficiency and conservation, environment, industry, agriculture, research and development etc, as well as for energy management issues such as energy financing, planning and policy implementation. With regards to power, it provides for the re-introduction of coal for power generation (especially with cleaner coal technologies), increased use of natural gas and expansion of the gas network (which should also facilitate the termination of natural gas flaring by 2008), further utilization of the balance (9GW) of large-scale hydropower potential in the country, utilization of the smaller-scale renewable energy technologies (solar, wind, micro-hydro etc), - especially for distributed, isolated and rural power supply as well as the development of nuclear power for electricity generation in the long term. Further provisions in respect of electricity include that:

a. The nation shall make steady and reliable electric power available at all times, at economic rates, for economic, industrial and social activities;
b. The nation shall continue to engage intensively in the development of electric power with a view to making reliable electricity available to 75% of the population by the year 2020
c. The nation shall promote private sector participation in the electricity sub-sector, while ensuring broad-based participation of Nigerians.

For oil and gas, the policy provides for the increase of the reserve base, increase in value added to the natural resources, expansion of the domestic consumption and network for gas, indigenous and foreign private sector participation in addition to the deregulation and privatization of the upstream and downstream sectors of the industry.

Apart from the role envisaged in the National Energy Policy for renewable energy in rural and isolated power supply, as indicated above, the policy provides for de-emphasizing the use of fuelwood but rather it promotes the use of renewable energy and other and technologies as alternatives to fuelwood. In this regard, the policy also promotes the use of smokeless coal briquettes in place of fuelwood.

2.6 Environmental Aspects

The most serious environmental problems in Nigeria are land degradation due to desertification, soil erosion, land and sea pollution due to natural gas flaring, oil spillages, oil waste leakages and discharges; atmospheric pollution from exhausts of vehicles, power plants and other combustion equipment; environmental pollution from municipal wastes and blocked gutters. Power generation has linkages to most of these aspects of environmental damage. The increased availability and use of electricity for lighting and cooking by higher and medium income households will reduce the pressure on kerosene. The latter fuel may then be more available to lower income households who may use more of it for cooking, thereby reducing the use of fuelwood and thus, reducing the latter's contribution to soil erosion and desertification.

With regards to natural gas flaring (23.9 and 27.9 billion m^3 in 2000 and 2002, respectively), government has set the target year of 2008 for its termination. Increased use of natural gas for power generation is one of the key strategies for achieving the target. Indeed, most power plants currently under construction or being planned are gas based. With a CO_2 ratio for gas, oil and coal of 1:1.43:1.95, respectively, natural gas is environmentally cleaner than oil and coal for power generation. Thus, from environmental considerations, the existing policy, which favours the use of natural gas, is in the right direction.

Environmental problems also arise from hydropower plants, though mostly of a different nature from those due to thermal power plants. They arise from the flooding of catchment areas, displacement of persons and loss of agriculture and other lands, the emission of methane and ammonia from decaying vegetable matter in flooded areas, and the growth and spread of some water borne disease vectors.

All new power plant projects are subject to Environmental Impact Assessments before approval for construction, as required by the environmental law.

CHAPTER THREE

3.0 OVERVIEW OF NIGERIA'S VISION: 2020

Vision 2020 is the Federal Government's postulation for industrialization that is to be amongst the first 20 industrialized countries in the world by the year 2020. Below is an overview of that vision in a tabular form.

Nigeria 2020 will be bustling with energy, entrepreneurship and innovation. The country's 160 million people will be better fed, dressed and housed, healthier, more educated and longer living than any generation in the country's long history. Illiteracy and all major contagious diseases would have disappeared. These are encapsulated in the Human Development Index (HDI) in which Nigeria is currently (2010) occupying the 142nd position to between 71 and 100. Table 3.1 gives a summary of the major assumptions of the Vision.

Table 3.1: Overview of Nigeria Vision 2020 Targets

	Baseline, 2007	2015	2020
GDP (at 2007 current price)	$212bn	>$400bn	>$900bn
Per Capital Income	$ 1473.35		>$4,000
GDP Growth Rate			average of 13.8%
Sectoral Contribution to GDP			
-Agriculture	42.10%		3% to 15%
-Industry	23.80%		30% to 50%
-Manufacturing	4%		15% to 30%
-Services	34.10%		45% to 75%
Pillar 1			
% of population living on less than $1/day	54.4	21	15
% of underweight children under the age of 15	30	18	10
% of population with sustainable access to improve water source	49	80	100
% of population with access to improved sanitation	35	65	80
Life expectancy	46.5	60	70

Under 5 mortality rate (per 1000 live birth)	110	63	22
Infant mortality rate (per 1000 live birth)	138	30	15
Maternal mortality rate (per 100,000 live birth)	800	100	70
Adult literacy rate (% aged 15 and above)	69.1	75	100
% of primary school enrolment of children aged 6-11	89.6	100	100
Ratio to female to male enrolments in tertiary education	69	100	100
% increase in number of housing units	NA	20	50
HDI index ranking (country Group)	Low Human Development (158)	Medium Human Development (100 - 155)	Medium Human Development (71-100)
Reduce the number of people who suffer from hunger and malnutrition		50%	75%
Increase irrigated arable land Home ownership to about 50%	1%	10%	25%
Pillar 2			
Aggregate GDP (at 2007 current price)	$212bn	>$400bn	>$900bn
Economic Structure (ratio of Agriculture, Industry and services contribution to GDP			
Agricultural Productivity	2009	3-fold increase	6-fold increase
Domestic refining Capacity	445,000bpd	750,000bpd	1,500,000bpd
Ratio of non-oil contribution to GDP	5 to 95	20 to 80	40 to 60
Average Local content value (material and human resources)across key industries			
Manufacturing contribution to GDP	4%	10%	25%
Private sector credit as a % of GDP	17%	30%	45%
Steel consumption per capital	10kg	40kg	100kg
Proven Oil Reserves	37.8bb	40bb	50bb
Proven Gas Reserves	187tcf	215tcf	250tcf
Pillar 3			
Inflation rate (%)(Dec-Dec)	15.10%	<9%	<9%
Ranking on ease of doing business index	125/180	<80	<60
Ranking on corruption perception index	121/180	<60	<60

Actual power generation capacity	6,000MW	20,000MW	35, 000MW
Private sector contribution to power generation	NA	50%	80%
Annual urbanization Rate	5.30%	4%	2%
Tele-density	45%	70%	100%
Gas Flares as a Percentage of total gas Production	40%	0% from 2010	0%
Tourism contribution to GDP	2.5% (2007)	5%	10%
Increase the computer Literacy rate/ penetration by		50%	80%
Forest Cover	6%	12%	18%

Source: Federal Government of Nigeria, Vision 2020 Blueprint

A look at the Vision 2020 Targets shows that the GDP will grow from US $212 in 2007 to US$ 400 in 2015 and US$ 900 in 2020. The per capita GDP is projected to increase from US$ 1473.35 in 2007 to US$ 4000 in 2020. To achieve these targets, the GDP is projected to grow at an average of 13.8% per annum over the period 2007 – 2020. Growing GDP at this rate requires enormous amount of energy.

Steel consumption, estimated at 10kg/person in 2007 is projected to increase to 40kg/person in 2015 and 100kg/ person 2020 for estimated populations of 188.7 million people in 2015 and 227 million people in 2020. Proven reserves of crude oil will increase from 37.8 billion barrels to 40 billion barrels and 50 billion barrels by 2015 and 2020 respectively. Similarly, natural gas reserves will increase from 187tcf in 2007 to 215tcf and 250tcf in to 2015 and 2020 respectively. Achieving these targets requires enormous amounts of energy.

CHAPTER FOUR

4.0 ENERGY DEMAND ANALYSIS

4.1 Energy Demand

Energy use is inextricably entwined with human history. Coal use helped fuel the industrial revolution of the 18th and 19th centuries; oil use has, inter alia, formed the basis of the mobility revolution of the 20th century. All fuel types have been used to increasingly provide access to electricity, which is powering the current information and communication revolution (OPEC 2010). A myriad of uses allows energy services to fuel economic growth, and bring about social progress. With the assumptions laid out in the Vision 2020, energy demand will continue to increase to 2020, as the national economy expands, the population grows and people's living conditions improve.

4.2 The MAED Model

The analysis of the energy demand projection was carried out using the MAED model which was developed by the IAEA. MAED evaluates future energy demand scenarios based on medium to long-term assumptions for socio-economic, technological and demographic development. The MAED model allows differentiation between energy demand for specific uses and substitutable energy demand. Energy demand is disaggregated into a number of end- use categories each corresponding to a given service or to the production of a certain good e.g. industrial sector, transport sector, household and services sectors.

The nature and level of the demand for goods and services are a function of several determining factors, including population growth, GDP growth rates and changes of GDP structure, number of inhabitants per dwelling, number of electrical appliances used in households, peoples' mobility and preferences for transport modes, national priority for the development of certain industries or economic sectors, evolution of the efficiencies of certain types of equipment, market penetration of new technologies or energy forms. The expected future dynamics for these determining factors are exogenously introduced.

The analysis and projection of total energy demand using MAED involved the following steps:

- Total final energy consumption is disaggregated into consumption by economic sector e.g. industrial, transport, household and services sectors. Energy consumption in the industrial sector is further divided into consumptions by manufacturing, mining, construction and agriculture. The energy consumption for each sector is categorized into specific energy types, both non-substitutable and substitutable;
- Assumptions on socio-economic development and evolution of technologies;
- A set of scenarios, each consistently reflecting future evolution of the energy determinants is prepared;
- The establishment of relationships between the energy demand and the socio-economic and technological factors identified for each end use category, and based on these relationships, final energy demand is calculated.

Four possible scenarios of the development of the economy were chosen based on the policy of the Nigerian government, namely: Reference Scenario (basic or moderate economic growth); High Growth Scenario (High economic growth); Optimistic I Scenario. Optimistic II Scenario (Vision 2020 Scenario).

Reference Scenario

The reference or low growth scenario was based on the possibility that the economy will evolve on the basis of 'business as usual' approach. The sectoral average growth rates recorded over the period (2009-2020) were therefore adopted for the first 5-year period of the plan. These were improved slightly over the remaining periods of the plan. The resulting overall annual growth rate for the total GDP over the plan period (2009-2020) is 7% per annum for this scenario.

High Growth Scenario

The overall growth rate of the economy over the plan period, for this scenario, is 10% p.a. Since agriculture and services constituted about 74.18% of the GDP their respective effective annual GDP growth rates for the plan period should not be greatly different from 10%, otherwise it would imply unrealistic growth rates for one or more of the other sub-sectors.

Optimistic I Scenario

The Optimistic I scenario with a DGP growth rate of 11.5% per annum was based on the possibility that the economy evolve faster than the 10% growth rate.

Optimistic II Scenario

The present administration pronounced a Vision 2020, which is aimed at taking Nigeria to the league of twenty (20) most developed economies in the world by year 2020. Nigeria is currently ranked 31st on GDP on PPP basis (Table 4.1). To achieve the vision, the administration intends to grow the economy at an average rate of 13.8% per annum. Thus this growth rate has been adopted as the Optimistic II Scenario. Hence, to be in the top 20 bracket, with a GDP of $900 million, Nigeria would have to displace at least the bottom five countries, namely, Turkey, Australia, Taiwan, Iran and Poland.

Table 4.1 World Top 20 Countries Based on GDP (PPP)

S/No.	**Country**	**GDP, $ Billion**
1	United States of America	14,660.00
2	China	10,090.00
3	Japan	4,310.00
4	India	4,060.00
5	Germany	2,940.00
6	Russia	2,223.00
7	United Kingdom	2,173.00
8	Brazil	2,172.00
9	France	2,145.00
10	Italy	1,774.00
11	Mexico	1,567.00
12	South Korea	1,459.00
13	Spain	1,369.00
14	Canada	1,330.00
15	Indonesia	1,030.00
16	Turkey	960.50
17	Australia	882.40
18	Taiwan	821.80
19	Iran	818.70
20	Poland	721.30
31	**Nigeria**	**380.23**

Source: International Monetary Fund, 2010

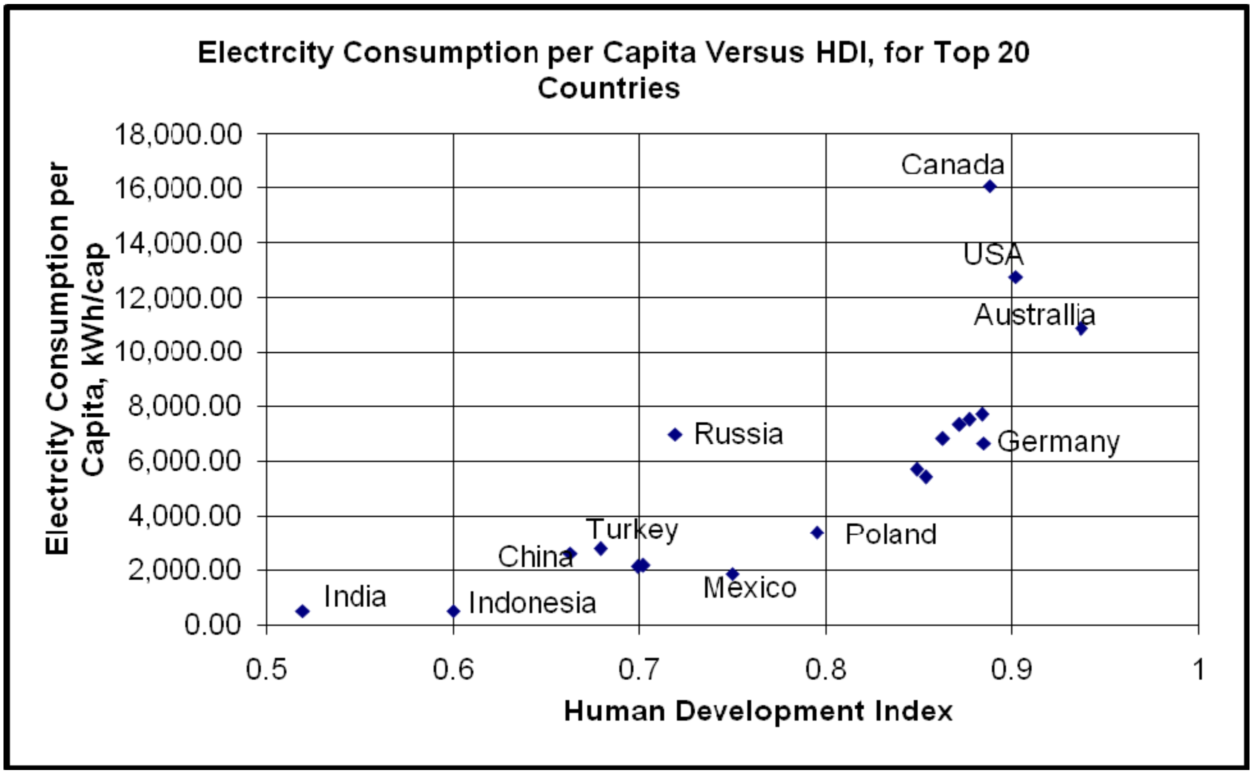


Fig. 4.1 Electricity consumption per capital versus HDI for top 20 countries

4.3 Assumptions for the Scenarios

The MAED model requires the determination of the future development of the most important indicators affecting energy demand in sectors of the national economy. The following are the main factors influencing the economic development: Demography; Economy Growth; Energy Efficiency; Freight and Passenger Transportation; Energy Consumptions.

4.4 Demography

The population projections were based on the 2006 population census data. Only one demographic scenario was considered for the four scenarios. It was assumed that the population growth rate will increase slightly from 3.2% per annum in 2009 to 3.8% per annum in 2020, based on assumptions regarding fertility, cultural practices, religious beliefs, mortality and migration, bringing the population to 188.7 million people in 2015 and 227 million people in 2020. A recent statement credited to the outgoing Chairman of the National Population Commission (NPC), Mr. Samu'ila Danko Makama while preparing this report after our calculations, shows that the current population is 167 million people. The statement also gave projections by NPC as 188 million people by 2015 and 221 million people by 2020. The projections are within 0.37% and 2.71% accuracies respectively, with the projections made in this study.

4.5 Energy Demand Analysis

4.5.1. Patterns of Energy Consumption

Prior to the 1960s, energy demand and consumption constituted, very predominantly, of non-commercial energy, namely, fuelwood, charcoal, agricultural wastes and residues and solar radiation. The major commercial fuel was coal, which was used by the railways and for power generation. Modest contributions came from petroleum products (petrol and diesel) and electricity (from coal and diesel generators).

The structure of energy demand has drastically changed since then. Commercial production of crude oil started in December 1957, with the first exports in 1958. Coal production peaked in 1959 and has experienced continued decline since then, due in part to the introduction of diesel powered engines in the railways in the 1960s and eventual stoppage of power production from coal. The first gas turbine power plant was built at Afam, near Port Harcourt, in 1965 with an initial capacity of 56 MW. The first domestic refinery was also commissioned in Port Harcourt in 1965, with a capacity of 60,000 bpd. Furthermore, the first hydroelectric power plant, Kainji, started operations in 1968 with an initial capacity of 320 MW. These developments signaled the beginning of the change in the structure of the energy sector from coal to petroleum dominance of commercial energy. They also signaled the beginnings of the eventual dominance of the economy by the energy sector, especially by the oil and gas sub-sector. Fig. 4.2 shows the projected demand for energy by source and types over the period 2009 – 2030 for the Optimistic II Scenario.

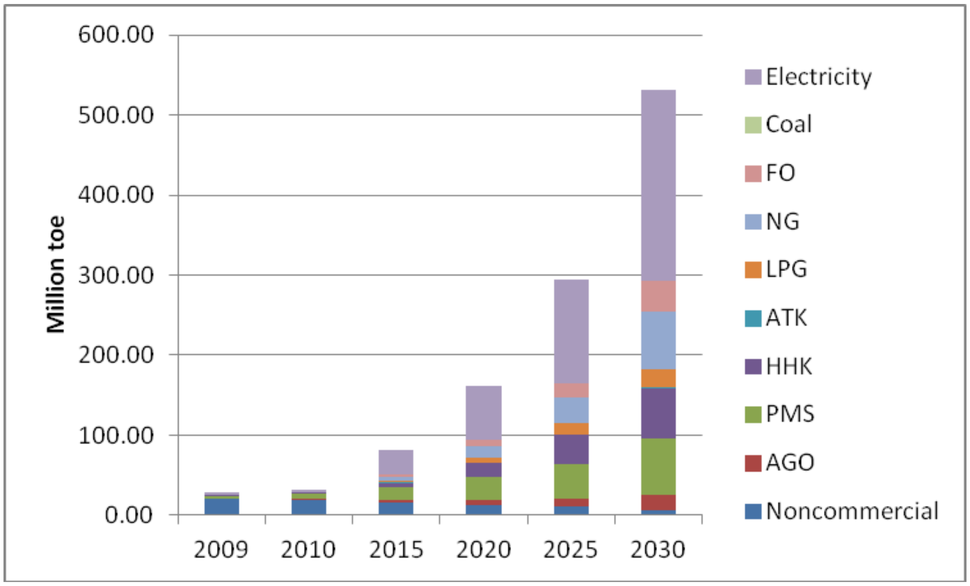
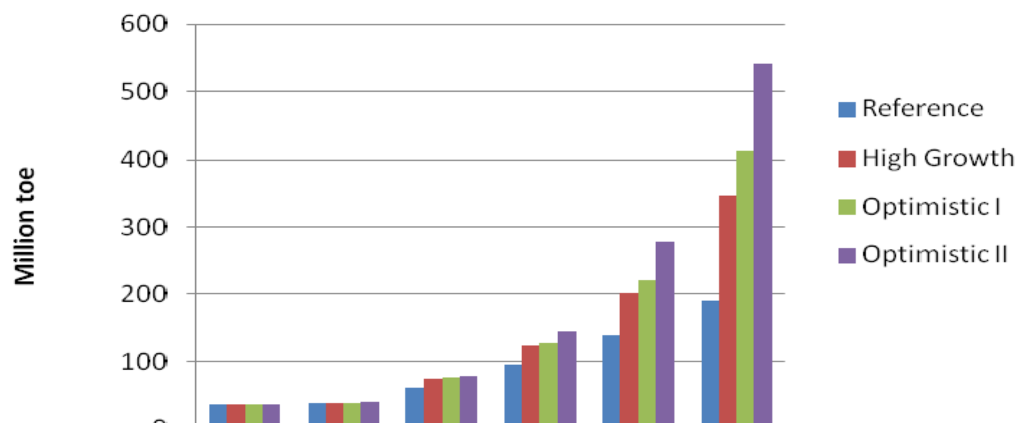


Figure 4.2 Consumption of Energy Sources

Up to the present, fuelwood and charcoal provided the single largest share of primary energy consumption in the country. Over the period 2009-2020, the share will decrease within the range of 55% - 5.3%. About 95% of the total fuelwood consumption was used in households for cooking and for cottage industries. A smaller proportion, of the fuelwood and charcoal consumed was used in the services sector (restaurants, schools, prisons, etc). The next most highly consumed energy resource was petroleum products with 36% in 2009 and 61% in 2020 consisting mostly of premium motor spirit (PMS) automotive gas oil (AGO) generally referred to as petrol and diesel for transportation and power generation, but also including kerosene (households), aviation kerosene (transport), fuel oil (industry), liquefied petroleum gas (households). Others include electricity 8.5% in 2009 and 27% in 2020 (i.e. thermal and appliances), natural gas 0.5% in 2009 and 6% in 2020 (steam production and feedstocks), in the manufacturing industries. However bulk of the natural gas consumption is captured in electricity generation. Furthermore, the use of natural gas as feedstock for liquefied natural gas production for export later became predominant. The share of oil product consumption by types in 2009-2020 is shown in the Figure 4.3.

4.5.2 Total Final Energy Demand

The total final energy demand will increase from 36.02 million toe (Mtoe) in the base year to 94.29, 124.16, 127.40 and 143.75 Mtoe in 2020 and 190.98, 346.90, 416.68 and 541.42 Mtoe in 2030 for the reference, high growth, optimistic I and optimistic II scenarios, respectively. The values include kerosene (fossil fuel) demand for lighting mostly in households and the services sectors. The growth rates of the total final energy demand over the period 2009-2030 are 10.85%, 16.32%, 15.79% and 19.90% p.a., for the reference, high growth, optimistic I and optimistic II scenarios respectively. The increase in the growth rates of energy demand for the reference, high growth and optimistic scenarios are due to additional energy requirements for increased economic activities especially with manufacturing sector making more contributions, increasing access to electricity by all the sectors of the economy, increasing mechanization and automation of the industrial sectors.



	2009	2010	2015	2020	2025	2030
Reference	36.02	37.11	61.43	94.29	138.84	190.98
High Growth	36.02	37.56	73.68	124.16	200.95	346.9
Optimistic I	36.02	38.15	75.68	127.4	220.31	413.68
Optimistic II	36.02	40.66	77.15	143.75	278.45	541.42

Fig. 4.4 Final Energy Demand in Nigeria Scenarios

Of the total final energy demand of 36.06Mtoe in the base year (2009), modern energy sources constituted 16.2Mtoe or 45%, while traditional energy (fuelwood, crop residue, animal dung and charcoal) constituted the balance of 20Mtoe or 55% (see fig. 4.2).

Table 4.2 shows the amounts of total final energy demand by the various sectors of the economy. In the reference case, the industrial energy demand will increase from 1.15 to 46.72 Mtoe by 2020 and to153.40 by 2035, at the overall growth rate of 16%. The demand in the industry will grow to 62.21 Mtoe at the overall growth rate of 26.38%, 66.20 Mtoe at the overall growth rate of 31.18% and 81.66 Mtoe at the overall growth rate of 39.93% in the High Growth, Optimistic I and Optimistic II growth scenarios by the year 2020, respectively. All other sectors indicate strong positive growths.

The rapid growth of the energy demand by the various sectors of the economy does not depend only on industrialization inclination but on high energy intensity too; the intensity is caused by several factors, which include:

- Inefficiency of old technologies;
- Old automobiles;
- Poor energy control;
- Inadequate metering of energy consumption

Table 4.2 Final Energy Demand by Sector (Mtoe)

Scenario / Year	**2009**	**2010**	**2015**	**2020**	**2025**	**2030**	**Annual growth rate**
Reference							
Total	**36.02**	**37.11**	**61.43**	**94.29**	**138.84**	**190.98**	8.27
Industry	1.15	0.47	23.34	46.72	73.80	105.52	24.01
Transport	7.65	9.26	11.63	15.53	21.12	28.51	6.46
Households	24.09	24.68	23.40	27.28	36.46	46.29	3.16
Services	3.13	2.71	3.055	4.76	7.46	10.67	6.01
High Growth Scenario							
Total	**36.02**	**37.56**	**73.94**	**124.16**	**200.95**	**346.90**	11.39
Industry	1.15	1.73	30.46	62.21	115.30	233.12	28.78
Transport	7.65	7.36	11.04	16.49	24.02	34.88	7.49
Households	24.09	27.32	30.44	39.53	52.16	65.15	4.85
Services	3.13	1.15	3.305	5.93	9.49	13.75	7.30
Optimistic I Scenario							
Total	**36.02**	**38.15**	**73.68**	**127.40**	**220.31**	**413.68**	12.33
Industry	1.15	3.05	30.00	66.20	134.79	300.01	30.34
Transport	7.65	8.69	11.07	16.50	24.20	35.50	7.58

Households	24.09	23.24	29.01	38.50	51.10	63.22	4.70
Services	3.13	3.17	3.600	6.20	10.22	14.95	7.73
Optimistic II Scenario							
Total	**36.02**	**40.66**	**77.15**	**143.75**	**278.45**	**541.42**	13.78
Industry	1.15	6.92	34.97	81.66	190.01	420.74	32.45
Transport	7.65	5.56	11.11	16.51	24.71	37.63	7.88
Households	24.09	24.72	26.3735	36.60	49.75	62.97	4.68
Services	3.13	3.46	4.70126	8.98	13.99	20.08	9.25

Table 4.3a: Projected Demand for Fuels, Reference and High Growth Scenarios

Reference Scenario (7%)	**2009**	**2010**	**2015**	**2020**	**2025**	**2030**
Noncommercial (ML Tonne of FW)	60.96	60.06	58.66	54.72	49.62	42.67
AGO (ML)	565.64	791.68	2301.86	4176.76	6231.84	8902.43
PMS (ML)	5096.94	6180.00	14460.00	28170.37	39769.44	56457.15
HHK (ML)	306.06	389.00	3510.00	8521.10	14354.21	21027.58
ATK (ML)	50.00	75.00	278.00	517.61	730.73	1037.35
LPG ('000 tonne)	74.16	93.20	1107.00	2862.50	4823.96	7029.22
NG (ML cum)	229.22	280.00	3480.00	8847.54	14910.13	21726.27
FO (ML)	120.01	160.00	1800.00	4632.07	7806.10	11374.64
Coal (tonne)	6.00	6.66	114.43	222.53	390.31	568.75

High Growth Scenario (10%)	**2009**	**2010**	**2015**	**2020**	**2025**	**2030**
Noncommercial (ML Tonne of FW)	60.99	60.06	55.23	49.62	42.20	30.84
AGO (ML)	565.64	977.20	2936.04	5126.83	8392.65	14623.94
PMS (ML)	5096.94	7490.00	16900.00	30723.00	49406.24	76379.28
HHK (ML)	306.06	590.00	4909.00	13658.72	24968.64	41650.22
ATK (ML)	50.00	94.00	360.00	580.00	907.80	1403.41
LPG ('000 tonne)	74.16	110.80	1429.80	3928.90	7476.76	15323.90
NG (ML cum)	229.22	340.00	4480.00	12143.63	23109.52	47797.26
FO (ML)	120.01	200.00	2460.00	6357.72	12098.84	25023.94
Coal (tonne)	6.00	7.50	146.43	317.89	660.00	1251.23

Table 4.3b: Projected Demand for Fuels, Optimistic I and Optimistic II Scenarios

Optimistic I Scenario (11.5%)	**2009**	**2010**	**2015**	**2020**	**2025**	**2030**
Noncommercial (ML Tonne of FW)	60.99	60.06	52.20	45.20	37.61	23.42
AGO (ML)	565.64	1072.35	3250.17	5780.33	9920.69	18270.18
PMS (ML)	5096.94	8370.00	18103.00	32512.11	53225.19	82712.31
HHK (ML)	306.06	685.00	6151.00	19113.38	33824.51	61147.19
ATK (ML)	50.00	108.00	398.00	607.38	978.31	1581.51
LPG ('000 tonne)	74.16	126.80	1680.45	5102.75	10012.52	19334.66
NG (ML cum)	229.22	410.00	5110.00	15101.56	34721.43	69243.34
FO (ML)	120.01	240.00	3011.00	8012.81	17003.12	36221.71
Coal (tonne)	6.00	8.13	178.54	371.56	842.00	1741.25

Optimistic II Scenario (13%)	**2009**	**2010**	**2015**	**2020**	**2025**	**2030**
Noncommercial (ML Tonne of FW)	60.96	60.06	49.85	40.81	31.63	18.78
AGO (ML)	565.64	1177.85	3651.10	6270.84	11408.42	21349.73
PMS (ML)	5096.94	8890.00	19510.00	35587.13	55459.38	88369.15
HHK (ML)	306.06	782.00	6599.00	22050.61	43266.41	75631.97
ATK (ML)	50.00	120.00	440.00	653.88	1019.02	1623.71
LPG ('000 tonne)	74.16	132.90	1871.20	5733.51	12852.25	22903.70
NG (ML cum)	229.22	450.00	5520.00	17721.43	39724.34	86799.68
FO (ML)	120.01	270.00	3380.00	9277.93	20797.42	45443.40
Coal (tonne)	6.00	8.82	215.75	429.00	1160.00	2272.22

4.6 Petroleum Products Demand Projections

Nigeria has four refineries with a combined refining capacity of 445,000 barrels of crude oil per day which is equivalent to 162.425 millions barrels of oil per year. The decomposed projected fuels demand, including petroleum fuels are presented in Tables 4.3a and 4.3b. give the Individual refining capacity of the refineries and their names/locations. The capacities of the units of the refineries are as follows:

Table 4.4 Capacities of Nigeria Refineries

Refinery	Year Commissioned	Daily Capacity, Barrels per stream day (BSPD)	Annual Capacity, Barrels per year (BPY)
Kaduna Refinery and Petrochemical Complex (KRPC)	1979	110,000	40,150,000
Warri Refinery and Petrochemical Complex (WRPC)	1978	125,000	45,625,000
New Port Harcourt Refinery and Petrochemical Complex (NPRPC)	1989	150,000	54,750,000
Old Port Harcourt Refinery and Petrochemical Complex (OPRPC)	1965	60,000	21,900,000
Total		**445,000**	**162,425,000**

Source: IAEA/ECN, 2008

From Table 4.4, the total capacity of the refineries per annum ise 162.425 million barrels of oil equivalent (Million BOE) at a daily refining capacity of 445,000.00 barrels per stream day (BPSD). Table 4.5 shows the design capacities of each refinery to produce different petroleum products per year, expressed in the both the natural units of measurement of the physical quantity as well as in energy units of million barrels of oil equivalent. Addition of the quantities gives 156.33 MBOE which produces a statistical difference of -3.75%, that is, less than the expected 162.425MBOE; this is due to shrinkage, different conversion factors, etc. Energy petroleum products (fuel gas, LPG, premium motor spirit (PMS), regular motor spirit (RMS), household kerosene, jet fuel oil, diesel fuel oils) account for about 92.40% of the refinery output while non-energy products (sulphur, waxes, lubricating oil, asphalt and carbon black or petroleum coke) account for the balance of 7.60% when all products are expressed in BOE.

Our survey and analysis of various reports show that 20% of the current consumption of petrol in the country is consumed for captive electricity generation in the household and services sectors. It is assumed that industry consumption of PMS for captive electricity generation is negligible and that all captive power generation in industry is by diesel generators. If grid electricity supply becomes more available with more access by households and industry, then the national demand for petrol and diesel for captive power generation will reduce gradually. Hence total demand for petrol and diesel consumption will be less than the projected for all the years in the study period.

Vision 2020 envisages that the capacity of domestic refineries will increase to 750,000 b/d by 2015 and 1,500,000 b/d by 2020. Using the design capacities of existing refineries for products as basis for the design of the additional refining capacities, the products output from the refineries would be as shown in Table 4.6. The total capacity of the existing and new refineries would still not produce enough petroleum products for consumption within the country and there would still be need for importation. For instance, the projected PMS, Jet Fuel Kerosene, Household kerosene and diesel consumption for the four scenarios in 2015 and 2020 and the refinery output are shown in Table 4.6 from which the following observations could be made:

(i) PMS demand will be 3.50 and 3.19 times the domestic production in 2015 and 2020 respectively;

(ii) Jet fuel kerosene will be 5.18 and 3.85 times the domestic production in 2015 and 2020 respectively;

(iii) Household kerosene demand will be 3.66 and 6.12 times the domestic production in 2015 and 2020 respectively; and

(iv) Diesel demand will be 1.58 and 1.35 times the domestic production in 2015 and 2020

A comparison of the annual production capacities of petroleum refineries to be established according to the Vision 2020 Blueprint with the refining capacities required for the production of energy petroleum products projected for the Optimistic II Scenario is presented in Fig.4.5. It shows that domestic production of petroleum products is consistently lower than demand in the period and the country will still depend on import petroleum products.

It should also be noted that the Old Port Harcourt Refinery is obsolete and that Nigeria's import dependency on petroleum products may be higher if the refinery is not rehabilitated. Over this period, 2009 – 2020, Nigeria would have produced about 10 billion barrels of crude oil out of the 37.2 billion barrels reserve and consumed a total of 3.4 billion barrels of crude oil internally.

These observations raise some policy issues. The additional refineries should be designed to be more flexible in the production of refined products, etc. There is need to encourage mass transportation to stem the growth rate of PMS demand which arises from high growth in passenger transportation demand by car.

Table 4.5 Design Capacities of Nigerian Refineries for Different Products

Product	Natural Unit	Kaduna	Warri	New Port – Harcourt	Old Port-Harcourt	Total, Natural Unit	Total, Million BOE	Percent of Total
Sulphur, tones	Tonnes	2,263	-	-	-	2,263	0.0004	0.00
Fuel Gas	Tonnes	338,720	-	-	91,250	429,970	3.22	2.06
Liquefied Petroleum Gas	Tonnes	10,037.50	1,648,340	129,210	20,075	1,807,663	14.30	9.15
Premium motor spirit	Litres	1,244,489,400	1,751,915,137.50	409,105,578.20	977,813,100	4,383,323,216	51.22	32.76
Regular Motor Spirit	Litres	668,700,440	-	361,660,056.20	-	1,030,360,496	0.00	0.00
Jet fuel kerosene	Litres	-	822,550,641	-	-	822,550,641	5.02	3.21
Household kerosene	Litres	799,189,400	-	1,234,280,233.20	492,523,700	2,525,993,333	15.40	9.85
Diesel	Litres	1,299,140,485	1,333,279,409.50	1,010,693,879.72	934,907,350	4,578,021,124	29.03	18.57
Low pour fuel oil	Litres	255,691,260	1,254,648,810	-	1,508,997,600	3,019,337,670	18.81	12.03
High pour fuel oil	Litres	341,300,550	-	-	855,195,000	1,196,495,550	7.45	4.77
Propane propylene (Petrochemical feedstock)	Tonnes	-	516,110,00	-	-	516,110	3.97	2.54
Waxes	Tonnes	24,455	-	-	-	24,455	0.18	0.11
H M Grade lubricating oil	Tonnes	197,465	-	-	-	197,465	1.43	0.92
MM Grade lubricating oil	Tonnes	52,925.0	-	-	-	52,925	0.38	0.25
Solid Grade Asphalt	Tonnes	454,425	-	-	-	454,425	3.33	2.13
Cut back Asphalt	Tonnes	234,330	-	-	-	234,330	1.72	1.10
Carbon black	Tonnes	-	141,072.50	-	-	141,073	0.86	0.55
						Total	156.33	100.00

Source: Adapted from Kayode Sote: “Beyond Crude Oil and Gas Resources”, pg 100 - 102

Table 4.6 Expected Output of Total New Refineries by Vision 2020, Million BOE

Product	Unit	2015	2020
Sulphur	MBOE	0.0007	0.0013
Fuel Gas	MBOE	5.30	10.59
Liquefied Petroleum Gas	MBOE	23.52	47.04
Premium Motor Spirit	MBOE	84.22	168.44
Regular Motor Spirit	MBOE	0.00	0.00
Jet Fuel kerosene	MBOE	8.25	16.50
Household kerosene	MBOE	25.33	50.66
Diesel	MBOE	47.73	95.47
Low Pour Fuel Oil	MBOE	30.93	61.87
High Pour Fuel Oil	MBOE	12.26	24.52
Propane propylene (Petrochemical feedstock)	MBOE	6.53	13.06
Waxes	MBOE	0.29	0.59
HM Grade lube oil	MBOE	2.36	4.71
MM Grade lube oils	MBOE	0.63	1.26
Solid Grade Asphalt	MBOE	5.48	10.95
Cut back Asphalt	MBOE	2.82	5.65
Carbon Black	MBOE	1.41	2.82
Total		**257.07**	**514.14**

Table 4.7 Comparison of Projected Demand for Petroleum Products with Refinery Output in Vision 2020, Million BOE

	2009	**2015**		**2020**	
Units are in MBOE	**Reference**	**Optimistic II Scenario**	**Vision 2020 Blueprint**	**Optimistic II Scenario**	**Vision 2020 Blueprint**
Premium Motor Spirit	218.61	294.96	84.22	538.01	168.44
Jet Fuel kerosene	27.01	42.76	8.25	63.54	16.50
Household kerosene	49.35	92.78	25.33	310.01	50.66
Diesel	47.47	75.30	47.73	129.32	95.47

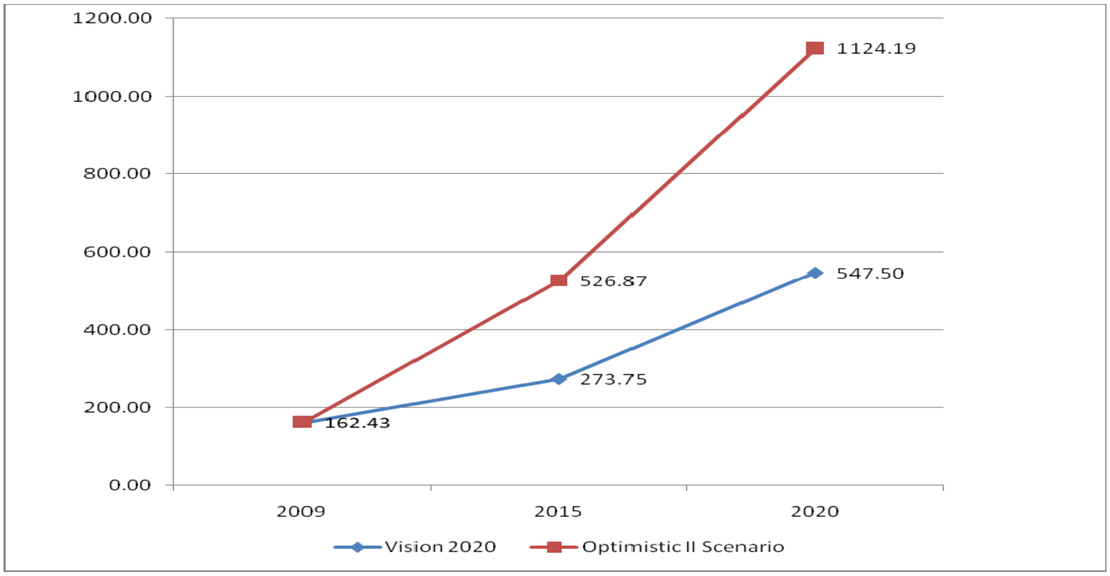


Fig. 4.5 Comparison of Vision 2020 Blueprint for Refining Capacity with Optimistic II Refinery Capacity Projections for Energy Petroleum Products, Million BOE/Year

Table 4.8 Petroleum Products Demand Less Demand of Products for Electricity Generation, (PMS -20%, AGO - 46%)

		2009	2015		2020	
Product	**Unit**	**Base Year**	**Optimistic Scenario II**	**Vision 2020**	**Optimistic Scenario II**	**Vision 2020**
Premium Motor Spirit	Million BOE	174.89	235.97	84.22	430.41	168.44
	Million litres	25026.76	33767.31	12051.88	61591.67	24103.76
Diesel	Million BOE	25.63	40.66	47.73	69.83	95.47
	Million litres	4075.17	6464.94	7589.07	11102.97	15179.73

Petrol and diesel are used for captive electricity generation in industrial, residential and services sectors of the economy because of inadequate supply of electricity from the national grid. This partly accounts for the high demand projections of petrol and diesel. If the public electricity demand is improved such that the proportions of petrol (20%) and diesel (46%) used for captive electricity generation would not be necessary, then the demand projections for petrol and diesel will be as shown in Table 4.7. Hence, petrol demand will be 2.8 and 2.56 folds the domestic production in 2015 and 2020 respectively while diesel demand would be 0.85 and 0.73 folds by 2015 and 2020 respectively. Thus, Nigeria could be a net exporter of diesel according to the Vision 2020 Blueprint.

4.7 Analysis of Electricity Demand Projections

The projected peak electricity demand for the four scenarios over the period 2009-2040 is shown in Table 4.8, which shows that for the Optimistic Scenario II which is equivalent to the Vision 2020 assumptions, the country should be producing about 88,000 MW. This is about twice the 40,000MW planned for supply in the Power Sector Roadmap. The corresponding per capita electricity consumption is shown in Fig.4.6. While the projected per capita electricity demand for the Optimistic II Scenario is 2408.8kWh/cap, by 2020 the per capita electricity consumption from the planned electricity supply in Power Sector Roadmap will be about 1340 kWh/cap, assuming all installed capacity to be operational and 10% transmission and distribution losses for a population of 227 million people.

Table 4.8 Peak Electricity Demand Projection, MW

Scenario /Year	**2009**	**2010**	**2015**	**2020**	**2025**	**2030**
Reference	4,052	7,440	24,380	45,490	79,798	115,674
High Growth	4,052	8,420	30,236	63,363	103,859	196,875
Optimistic Scenario I	4,052	9,400	36,124	76,124	145,113	251,224
Optimistic Scenario II	4,052	10,230	41,133	88,282	170,901	315,113

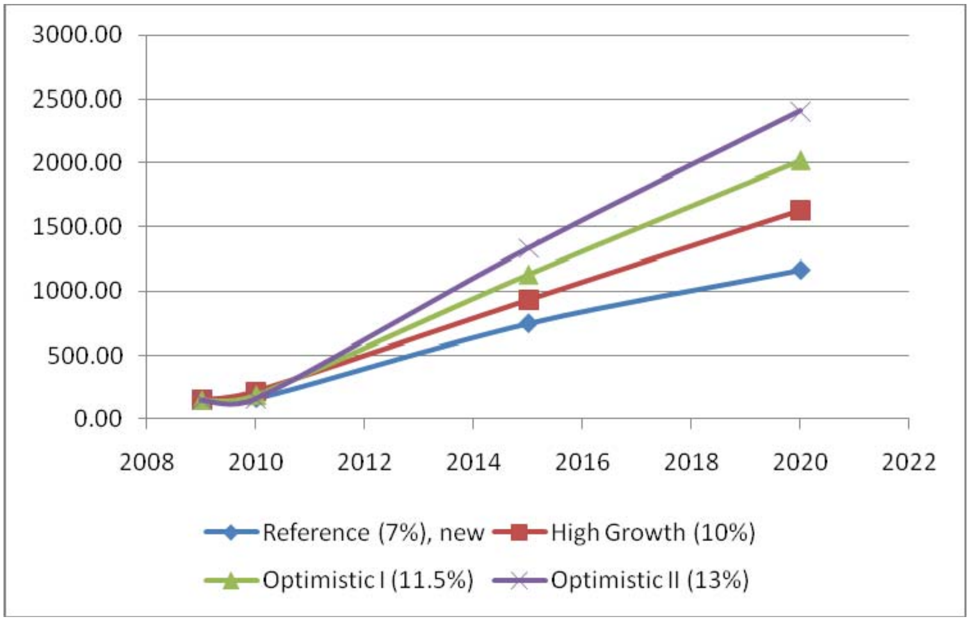


Fig.4.6 Projected Per Capita Electricity Demand, kWh/cap

4.8 Electricity Consumption per Capita Projection of bottom Six Countries of the World Twenty (20) Top Twenty GDP_PPP Countries

The historic data of electricity consumption per capita of the bottom six (6) of the top 20 countries from 2003 to 2007 were obtained and used to calculate the average growth rate of their electricity consumption per capita, the result of which is presented in Table 4.9 and Fig. 4.7.

Table 4.9 Electricity Consumption Per Capita (kWh/cap), of Bottom Six (6) Countries of World Top 20 GDP (PPP)

	2003	**2004**	**2005**	**2006**	**2007**	**Growth Rates (G.R)**				**Av. G.R**
	kWh per capita									
Indonesia	474	484	477	496	508	0.021	-0.015	0.038	0.024	1.7
Turkey	-	-	1790	1940	2756	-	-	0.077	0.296	18.7
Australia	10099	10427	10812	10721	10864	0.031	0.036	-0.009	0.013	1.8
Taiwan	-	9059	8806	9594	9594	-	-0.029	0.082	0.00	1.8
Iran	1990	2156	1996	2160	2160	0.077	-0.08	0.076	0.00	1.8
Poland	-	3250	3155	3311	3357	-	-0.030	0.047	0.014	1.0

Source:-http://www.nationmaster.com/graph/ene_ele_con_percap-energy-electricity-consumption-per-capita;

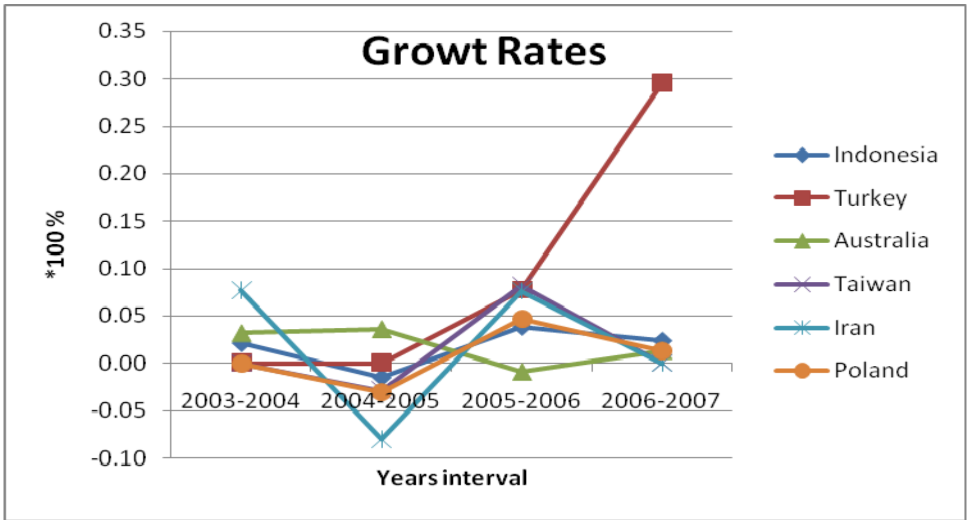


Fig. 4.7 Growth Rates of Electricity Consumption per Capita of some countries

In 2007, Indonesia was the country with the lowest electricity consumption per capita in the bottom six (6) countries of the top 20 GDP_PPP countries in the world consuming 508 kWh/capita which is about four times that of Nigeria that was consuming 142.26 kWh / capita in the same period. Using the above average growth rates, we can project and see how their electricity consumption per capita would be like. Indonesia with an average growth rate of 1.7%, Turkey 18.7%, Australia, Taiwan and Iran all having 1.8% and Poland 1.0%, when projected may be consuming 632.86 kWh/capita, 25594.02 kWh/capita, 13699.69 kWh/capita, 12098.20 kWh/capita, 2723.80 kWh/capita, and 3820.58kwh/capita respectively. The result of the projection is presented in Table 4.10.

Table 4.10 Electricity consumption per capita projection of bottom six countries of world top twenty GDP_PPP

	Indonesia	**Turkey**	**Australia**	**Taiwan**	**Iran**	**Poland**
	kWh /capita					
2007	508.00	2756.00	10864.00	9594.00	2160.00	3357.00
2008	516.96	3271.37	11059.55	9766.69	2198.88	3390.57
2009	525.75	3883.12	11258.62	9942.49	2238.46	3424.48
2010	534.69	4609.26	11461.28	10121.46	2278.75	3458.72
2011	543.78	5471.19	11667.58	10303.64	2319.77	3493.31
2012	553.02	6494.31	11877.60	10489.11	2361.53	3528.24
2013	562.42	7708.74	12091.40	10677.91	2404.03	3563.52
2014	571.98	9150.28	12309.04	10870.12	2447.31	3599.16
2015	581.71	10861.38	12530.60	11065.78	2491.36	3635.15
2016	591.60	12892.46	12756.15	11264.96	2536.20	3671.50
2017	601.65	15303.35	12985.76	11467.73	2581.85	3708.22
2018	611.88	18165.07	13219.51	11674.15	2628.33	3745.30
2019	622.28	21561.94	13457.46	11884.28	2675.64	3782.75
2020	632.86	25594.02	13699.69	12098.20	2723.80	3820.58

From the result of the analysis in Section 4.6, Nigeria will be consuming 2408.8kWh/capita in the year 2020 at GDP growth rate of 13.8%. This is more than three times what Indonesia may be consuming at the same period. Nigeria will be in league of Iran and Turkey that may be consuming 2156 kWh/capita and 2723 kWh/capita respectively. With projected population of about 227.40 million people in year 2020, this per capita consumption can be achieved when there is electricity in excess of 88.28 thousand MW for consumption.

The Nigeria's Vision: 2020 goal is to generate, transmit and distribute 35,000MW of electricity by the year 2020, although this was revised to 40,000MW in the Power Sector Roadmap. The Vision went ahead to make some medium term plans. In the medium term, the goal is to generate, transmit and distribute 16,000MW of electricity by 2013. Specifically, the overall target for the plan period is to increase electricity generation, transmission and distribution from the 3,700MW capacity as at December, 2009 to 8,000MW by 2010, and 16,000MW by 2013. Access to electricity is expected to increase from the current 40 per cent to 50 per cent, while per capita consumption will increase from the current 125kWh to 500kWh over the plan period.

With 500kWh/capita in 2013, Nigeria may be consuming more electricity per capita close to that of Indonesia that may be consuming 553.02kWh/capita in the same period. Considering 40,000 MW of electricity by 2020, with about 227.40 million people, consumption per capita will be about 1340 kWh/capita. This figure is more than what Indonesia may be consuming.

The essence of these analyses is that the bottom six countries will not remain static in their development goals. They would also strive to improve their development indices in terms of GDP, GDP per capita and hence electricity consumption per capita, which can serve as an index for measuring whether Nigeria will be able to catch up with the pace of development of these countries.

4.9 Electricity Demand Projections and Human Development Index

A central objective of the UNDP Human Development Report (HDR) for the past 20 years has been to emphasize that development is primarily and fundamentally about people. The main objective of human development, as stated in the Human Development Report of the United Nations Development Programme (UNDP), is to create an enabling environment for people to enjoy long, healthy, and creative lives. In this context, income (GNP, GDP, GDP/capita) and economic growth are means and not an end to development, and people's wellbeing depends on how income is used to achieve higher quality of living standards. The UN analyzed various concepts raised in earlier development discussions and placed them in a comprehensive framework of human development that was defined as "a process of enlarging people's choices; the most critical ones are to lead a long and healthy life, to be educated and to enjoy a decent standard of living" (UNDP, 1990). The HDI itself is clearly a reductionist measure, incorporating just a subset of possible human choices; additional choices include political freedom, guaranteed human rights and self-respect.

Human Development Index (HDI), a measure of human well-being is compiled annually by the UNDP for each and every country. It was developed to capture the overall socio-economic health of a country due to the limitations of GDP. The HDI measures the average achievements in a country in three basic dimensions of human development:
(i) life expectancy at birth, (ii) level of education, and (iii) Gross Domestic Product (GDP) per capita. Life expectancy at birth is the index for population health and longevity. Knowledge and education is measured by the adult literacy rate (with two – thirds weighting) and the combined primary, secondary and tertiary gross enrollment ratio (with one third weighting). Standard of living is measured by the GDP per capita at purchasing power parity. Generally, HDI ranges from a theoretical minimum of zero (for a life expectancy of 25 years, complete illiteracy and a GDP per capita of $100 at purchasing power parity) to a theoretical maximum of one (for a life expectancy of 85 years, 100% adult literacy and a GDP per capita of $40,000 at purchasing power parity). In practice, the observed range is 0.3 – 0.97 (UNDP, 2005; Manuel G. 2006).

The causal relationship between energy consumption and HDI is being studied increasingly in the literature of energy economics and development. This reflects the growing awareness of the international community of the close correlation between human development levels and access to modern energy: countries with low HDI tend to have low energy access and a high proportion of the population relying on traditional biomass. Energy is thus an important vector for triggering economic development and for reaching the Vision 2020.

This study has taken this issue into consideration because one of the cardinal objectives of the Vision 2020 Blueprint is to improve the position of Nigeria in HDI ranking from the current 142 to between 100 and 142 by 2015 and 71 and 100 by 2020. Countries with HDI ranking between 71 and 100 are those in the medium human development brackets. Table 4.11 shows the top 20 countries in terms of GDP in purchasing power parity, the corresponding HDI and the ranking, and the electricity consumption per capita in the countries. Fig. 4.8 shows a graph of the electricity consumption per capita versus the HDI. It can be seen that countries with the lowest electricity consumption per capita

(India and Indonesia) have the lowest HDI's while countries with the highest electricity consumption per capita (Australia, USA) have the highest HDI's.

Table 4.11 HDI of Top 20 Countries

S/ No.	**Country**	**GDP, $ Million**	**HDI**	**HDI Ranking**	**Electricity Consumption per capita, kWh/cap**	**Year of per capita electricity consumption data**
1	United States of America	14,660.00	0.902	4	12,747.485	2008
2	China	10,090.00	0.663	89	2,584.876	2008
3	Japan	4,310.00	0.884	11	7,710.962	2006
4	India	4,060.00	0.519	119	502.714	2007
5	Germany	2,940.00	0.885	10	6,641.91	2007
6	Russia	2,223.00	0.719	65	6,968.565	2007
7	United Kingdom	2,173.00	0.849	26	5,659.724	2007
8	Brazil	2,172.00	0.699	73	2,116.723	2007
9	France	2,145.00	0.872	14	7,328.281	2006
10	Italy	1,774.00	0.854	23	5,417.236	2007
11	Mexico	1,567.00	0.750	56	1,858.310	2007
12	South Korea	1,459.00	0.877	12	7,515.579	2007
13	Spain	1,369.00	0.863	20	6,818.79	2008
14	Canada	1,330.00	0.888	8	16,055.64	2007
15	Indonesia	1,030.00	0.600	108	508.321	2007
16	Turkey	960.50	0.679	83	2,755.491	2008
17	Australia	882.40	0.937	2	10,864.15	2007
18	Taiwan	821.80				
19	Iran	818.70	0.702	70	2,160.441	2006
20	Poland	721.30	0.795	41	3,356.851	2007
31	**Nigeria**	**380.23**	**0.423**	**178**	**142.263**	**2007**

Sources: IMF 2010; UNDP, 2010 ; http://www.nationmaster.com/graph/ene_ele_con_percap-energy-electricity-consumption-per-capita, 25/11/2011

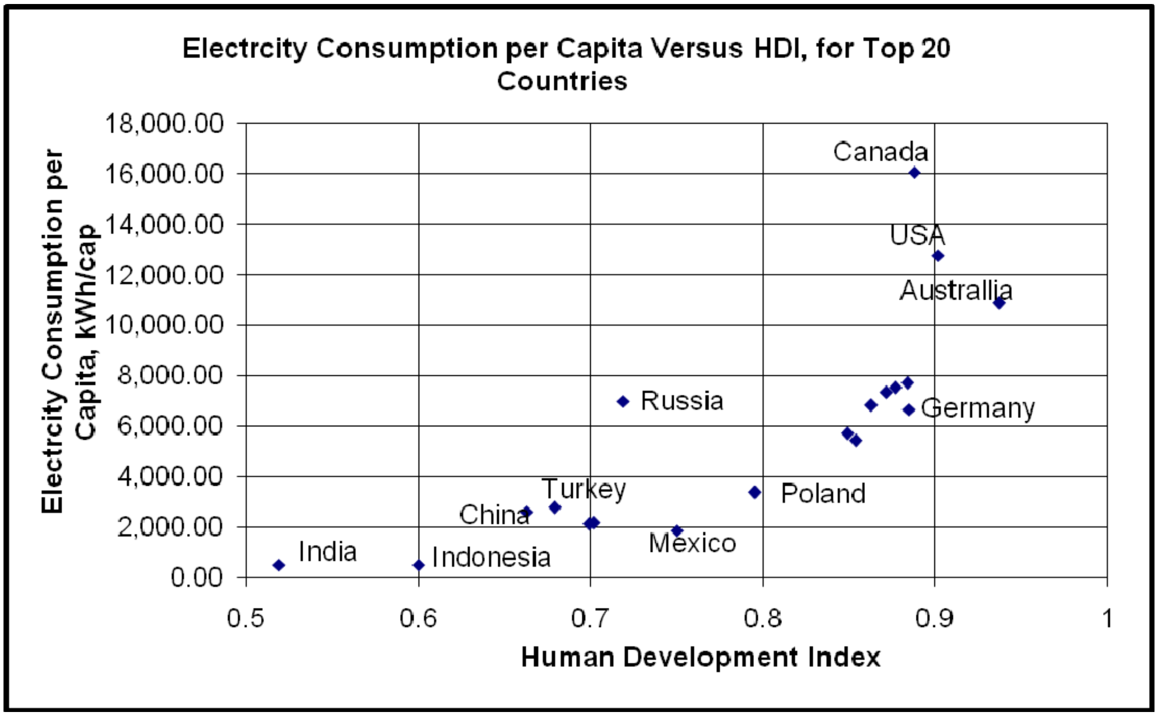


Fig. 4.8 Electricity Consumption per Capita versus HDI for Top 20 Countries

Table 4.12 and fig. 4.9 show the countries in the medium HDI brackets, that is, 71 – 100 that Nigeria aspires to be by 2020. The HDIs of these countries ranged between 0.622 and 0.701. The average HDI for the group is 0.669 while the average per capita electricity consumption for the group is 1,523.57 kWh/cap. This would give about 39,500MW capacity which must be operational throughout the year, without any downtime. To be on the safe side, there must be reserve capacity which varies from country to country depending on the levels of stability each country wants to achieve and there must be provision for transmission and distribution losses. A reserve margin of 10% would give about 4,000MW, which is about the operational capacity at present, while transmission and distribution losses of 10% would also give about 4,000MW. Hence we need to have additional 8,000MW if we want to operate at 40,000MW capacity.

Table 4.12 Medium HDI Countries

S/No.	Country	HDI 2010	HDI Ranking	Electricity Consumption kWh/capita	Year
1	Macedonia	0.701	71	4,207.86	2007
2	Mauritius	0.701	72	1,725.18	2007
3	Brazil	0.699	73	2,116.73	2007
4	Georgia	0.698	74	1,490.44	2008
5	Venezuela	0.696	75	3,190.19	2007
6	Armenia	0.695	76	1,653.52	2007
7	Ecuador	0.695	77	1,149.34	2007
8	Belize	0.694	78	674.287	2007
9	Colombia	0.689	79	869.544	2007
10	Jamaica	0.688	80	2,282.27	2007
11	Tunisia	0.683	81	1,136.41	2008
12	Jordan	0.681	82	1,718.10	2007
13	Turkey	0.679	83	2,755.49	2008
14	Algeria	0.677	84	850.203	2007
15	Tonga	0.677	85	342.026	2007
16	Fiji	0.669	86	939.396	2007
17	Turkmenistan	0.669	87	1,957.15	2006
18	Dominican Republic	0.663	88	1,356.00	2007
19	China	0.663	89	2,584.88	2008
20	El Salvador	0.659	90	637.011	2007
21	Sri Lanka	0.658	91	398.367	2007
22	Thailand	0.654	92	2,052.12	2008
23	Gabon	0.648	93	993.905	2007
24	Suriname	0.646	94	3,116.08	2007
25	Bolivia, Plurinational State of	0.643	95	447.432	2010
26	Paraguay	0.64	96	899.674	2007
27	Philippines	0.638	97	556.096	2006
28	Botswana	0.633	98	1,458.55	2007
29	Moldova, Republic of	0.623	99	1,011.46	2007
30	Mongolia	0.622	100	1,137.48	2006
31	**Nigeria**	**0.423**	**178**	**142.263**	**2007**

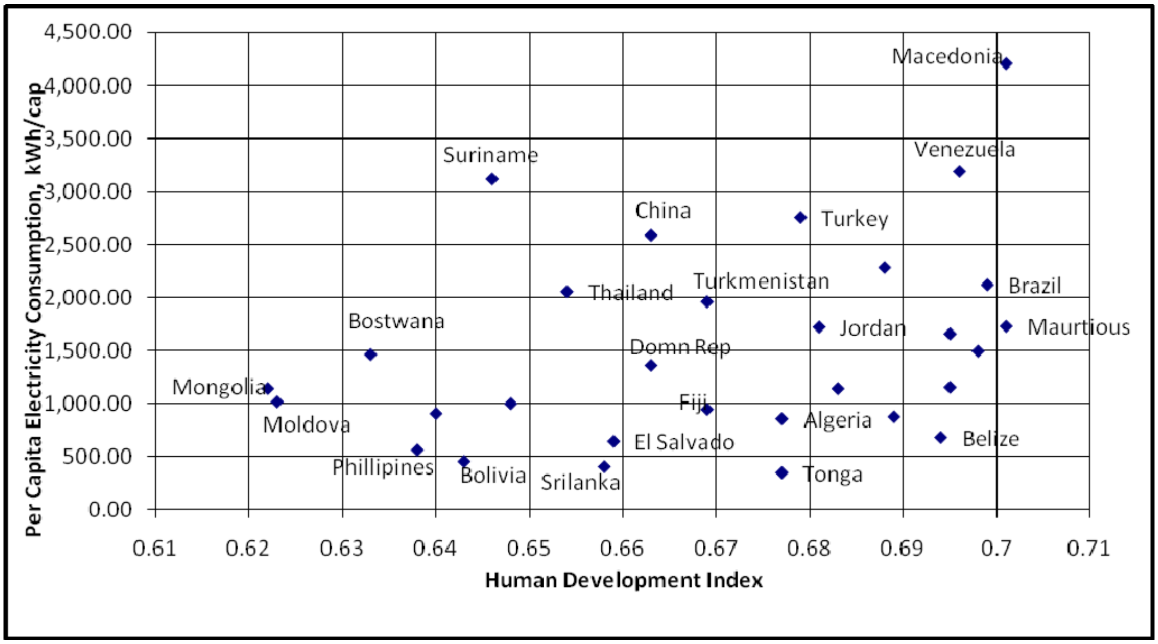


Fig. 4.9 Medium HDI Countries

CHAPTER FIVE

5.0 ENERGY SUPPLY STRATEGIES

This Chapter covers the energy supply strategy using the Model for Energy Supply Strategy Alternatives and their General Environmental impacts (MESSAGE). The supply study covers 2010-2040.

5.1 Optimal Energy Supply Strategies

For the present study, four energy supply scenarios have been developed, like the demand scenarios (see section 4.2), with two options for each. The first option is the business-as-usual (BAU) strategy with the conventional fuel contributing most of the fuel. Whilst the second strategy take cognizant of the climate and renewable to contribute at least 50% of the energy supply.

5.2 Techno-economic Data for Future Power and Refinery Plants

This study focuses on the power, oil and gas planning and competiveness of alternative electricity generation and oil refining options. In additions to fuel availability, the price of fuels and techno-economic data for the future plants are critical in determining the competitiveness of the alternative sources of electricity generation. Table 5. 1 provides the assumed input parameters for electricity generation and oil refineries technologies modeled in this study. These data have been obtained from various published and analyzed to conform to local situation. The cost does not represent the final contractual sum. The MESSAGE model has been applied to find optimum expansion path of the energy/electricity sectors in all the four scenarios.

Table 5.1: Data for Future Power and Refinery Plants

Name	Investment Cost ($/kW)	Variable O&M Cost ($/kWyr)	Fixed O&M Cost ($/kWyr)	Plant Factor (Fraction)	Construction Period (Year)	Efficiency (Fraction)
CCGT (I-XVI)	1000-1200	480.92	14.90	0.8	3	0.55
GT (I-VII)	800-900	613.20	35.92	0.8	3	0.33
Coal (I-VI)	1400-1600	231.26	55.19	0.5	3	0.33
Large Hydro	2500	62.19	30.66	0.5	5	N/A
Small Hydro	2500	62.19	30.66	0.8	4	N/A
Nuclear	2500	82.34	102.49	0.8	6	0.33
Wind Offshore	2200	0.1	208.40	0.35	2	N/A
Wind Onshore	2000	0.1	91.10	0.35	2	N/A
Solar PV	4000	0.1	56.06	0.4	1	N/A
Solar Thermal	3000	0.1	190.90	0.7	3	N/A
Refinery	2100					

5.3 Results of the MESSAGE Model

5.3.1 Total Primary Energy Requirement

The total primary energy for the Reference and High Growth Scenarios are presented in Tables 5.2 and 5.3 respectively. Nigeria will start importation of the crude oil by 2035 and 2030 in the Reference scenario and the High Growth Scenario if new discoveries are not made. Also importation of coal and natural gas is eminent for the High Growth Scenario by 2040 (Table 5.3).

Table 5.2: Primary Energy in ktoe (Reference Scenario)

S/N	Fuel	2010	2015	2020	2025	2030	2035	2040
1	Coal	38	2640	17184	41150	65216	87389	118469
2	Coal Import	-	-	-	-	-	-	-
3	Crude Oil	7714	23277	179701	253693	360146	11041	-
4	Crude Oil Import	-	-	-	-	-	478364	625151
5	Natural Gas	10681	33436	45035	68627	101202	125598	157541
6	Natural Gas Import	-	-	-	-	-	-	-
7	Nuclear Fuel Import	-	-	-	2594	7566	11350	15133
8	Non Commercial	20535	20060	18712	16967	14589	10307	7929
9	Renewables	701	2608	7175	10768	14319	17914	23307

Table 5.3: Primary Energy in ktoe (High Growth Scenario)

S/N	Fuel	2010	2015	2020	2025	2030	2035	2040
1	Coal	129	2,838	26,432	66,879	109,440	169,016	2,916
2	Coal Import	-	-	-	-	-	-	224,039
3	Crude Oil	7,714	23,277	195,984	317,491	291,105	-	-
4	Crude Oil Import	-	-	-	-	193,796	722,145	993,940
5	Natural Gas	10,734	42,072	58,261	83,556	159,785	256,931	309,376
6	Natural Gas Import	-	-	-	-	-	-	98,021
7	Nuclear Fuel Import	-	-	-	10,459	31,377	43,579	69,727
8	Non Commercial	20,297	18,886	16,967	14,430	10,545	3,964	2,379
9	Renewables	701	2,118	8,976	13,294	27,145	40,303	53,507

Non-commercial (firewood) will contribute the highest share of the total primary energy in 2010 as shown in Figures 5.1[a] & 5.2[a] for the Reference and High Growth Scenarios, respectively. The dominance of the firewood will reduce by the introduction and availability of the clean and modern fossil fuel like natural gas, coal briquette, kerosene and fuel oil for heating purposes (Fig. 5.1[b] & 5.2[b]). The total primary energy for the Reference Scenario will increase from about 50,000ktoe to about 950,000ktoe by 2040 (Fig. 5.3). Figure 5.4 shows the High Growth Scenario increasing to almost 1,800,000ktoe with refined oil product contributing the highest of the primary energy mix.

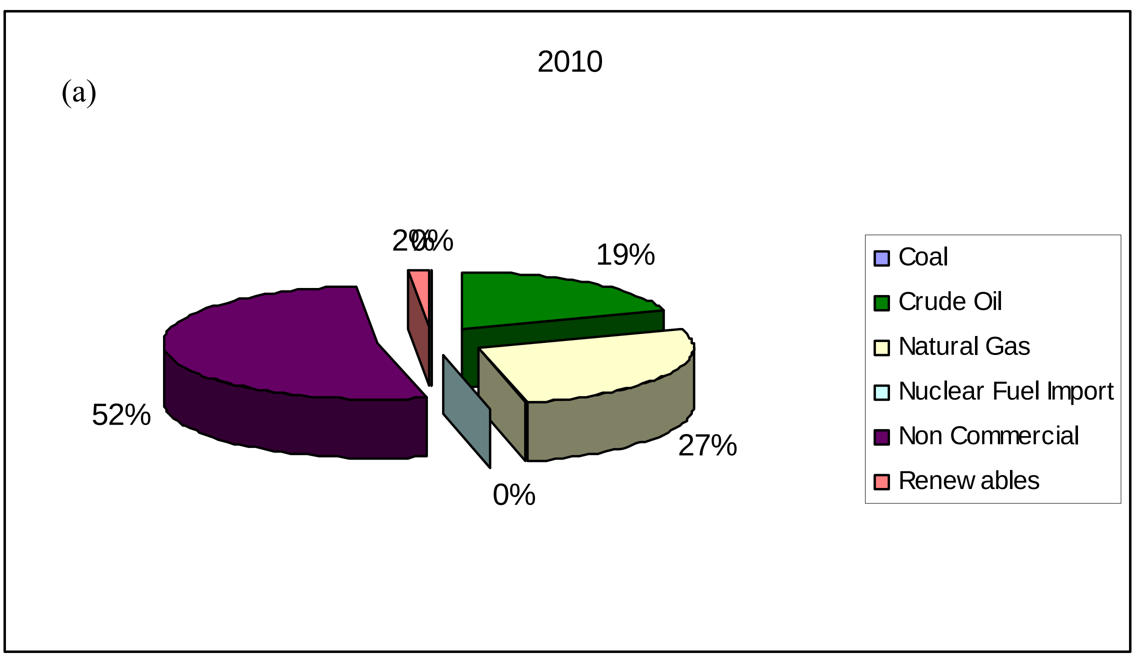


Fig. 5.1: Share of Primary Energy in percentage for the Reference Scenario in 2010 and 2040

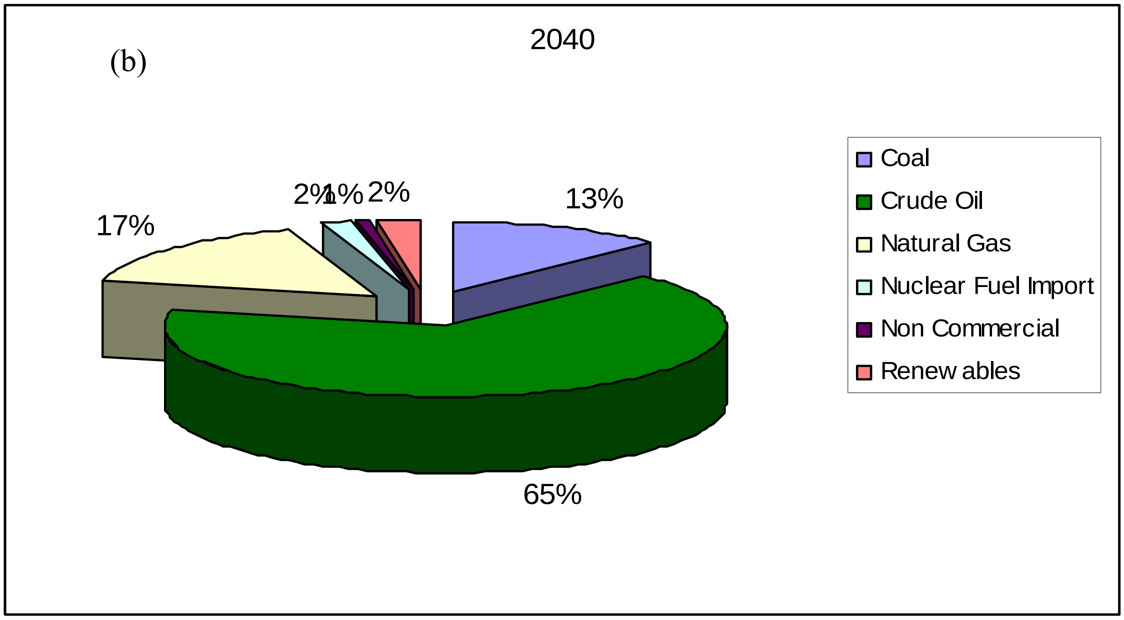


Fig. 5.1: Share of Primary Energy in percentage for the Reference Scenario in 2010 and 2040

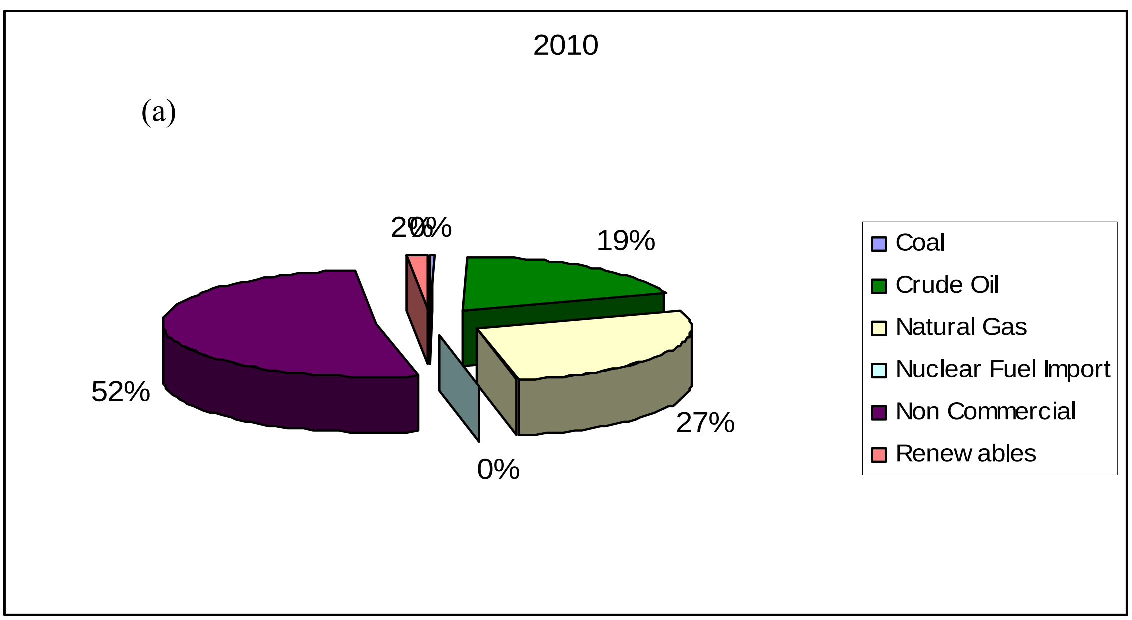


Fig. 5.2: Share of Primary Energy in percentage for the High Growth Scenario in 2010 and 2040

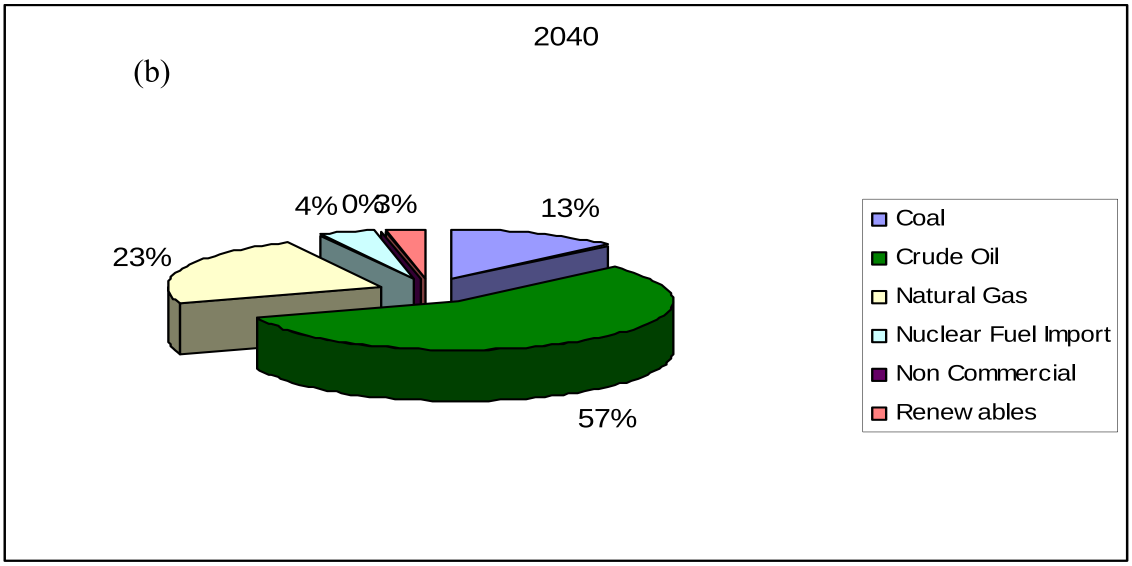


Fig. 5.2 Share of Primary Energy in percentage for the High Growth Scenario in 2010 and 2040

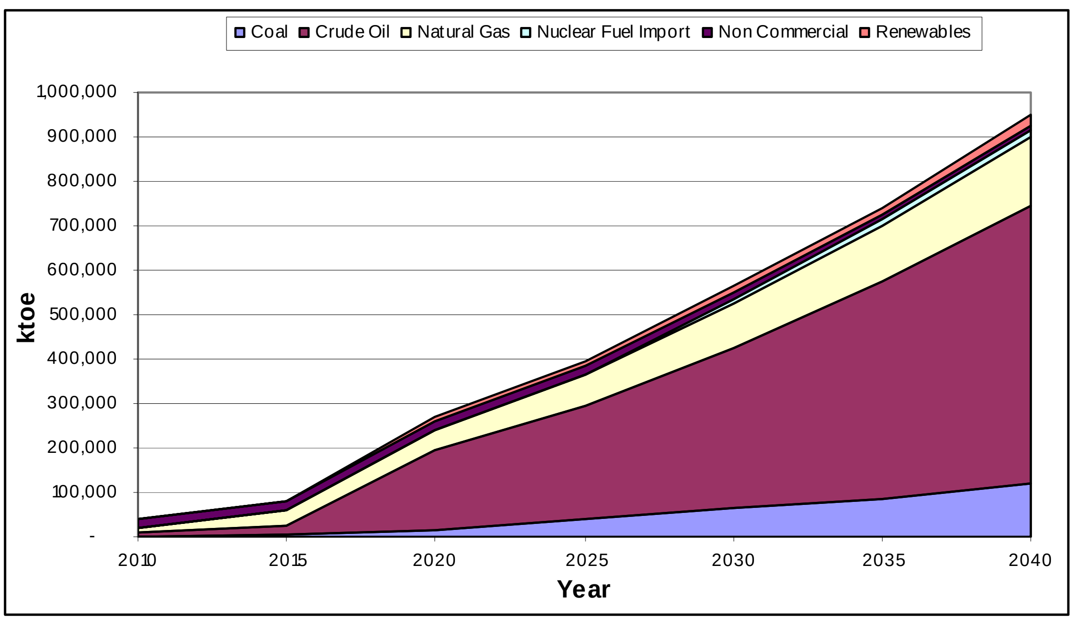


Fig. 5.3: Total Primary Energy (Reference Scenario)

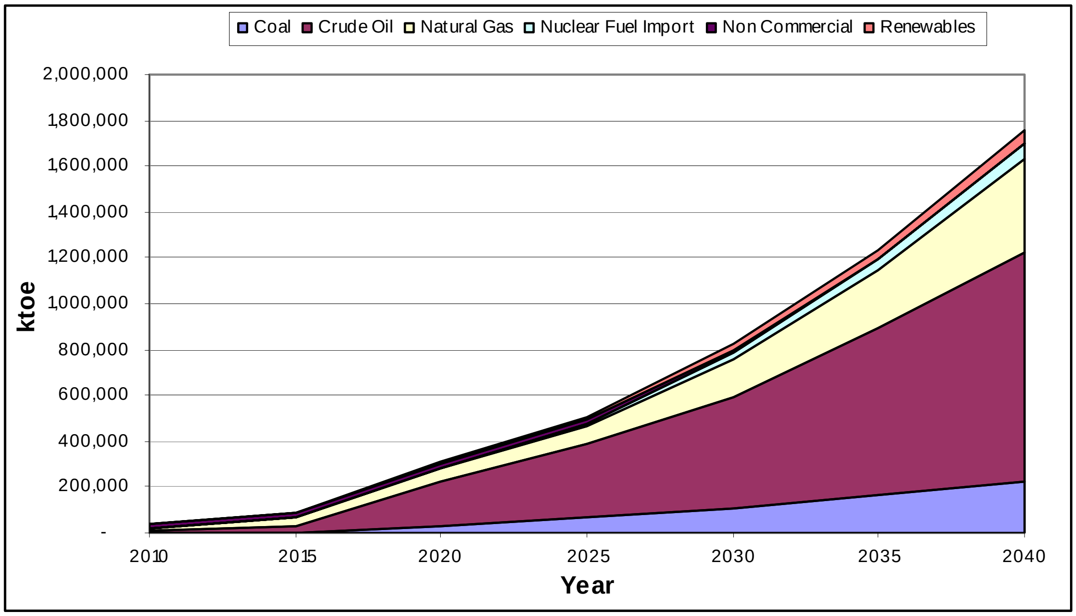


Fig. 5.4: Total Primary Energy (High Growth Scenario)

5.3.2 Capacity Additions for Electricity Generation

Capacity additions in the power sector for all the scenarios are given in appendices I and II. The study team has constrained the capacity additions based on hydro, coal, gas, nuclear and renewable, considering their supply potentials and other techno-economic barriers.

The Total installed capacity of the power sector includes the existing, NIPPs, IPPs and candid plants. The total installed capacity for the reference scenario is 45,219MW & 239,158 MW by 2020 & 2040. Whilst for the high growth is 81,529MW and 587,622MW by the year 2020 and 2040. The periodic addition is given below (Table 5.4), with an annual average increment of 7,839MW and 19,454MW for reference and high growth scenarios, respectively.

Table 5.4: Periodic Addition of Power Plant in MW

	2010	2015	2020	2025	2030	2035	2040	Annual Average Increment
Reference Scenario	9,703	5,044	26,472	36,107	42,185	54,511	61,136	7,839
High Growth Scenario	9,703	19,443	48,383	70,672	103,473	155,436	176,512	19,454

The standby and embedded generation owned by some household, industries and commercial establishments, which are intended for operations during extended periods of blackouts or brownouts, are not captured due to non information on the total installed capacity of these captive generations.

5.3.3 Electricity Supply Projection

The initial fuel mix for electricity generation in Nigeria is only two types, the hydro and gas fuels. One of the objectives of the National Energy Policy is to broaden the energy options for generating electricity. Eight different types of fuels were used for optimization. These are gas, hydro coal, nuclear, small hydro, biomass, solar and wind. The contributions of these fuels to electricity generation options have considerably changed the supply of electricity pattern in the country over the period of study. The electricity generation mix for the reference and high growth scenarios are shown in Figures 5.5 and 5.6.

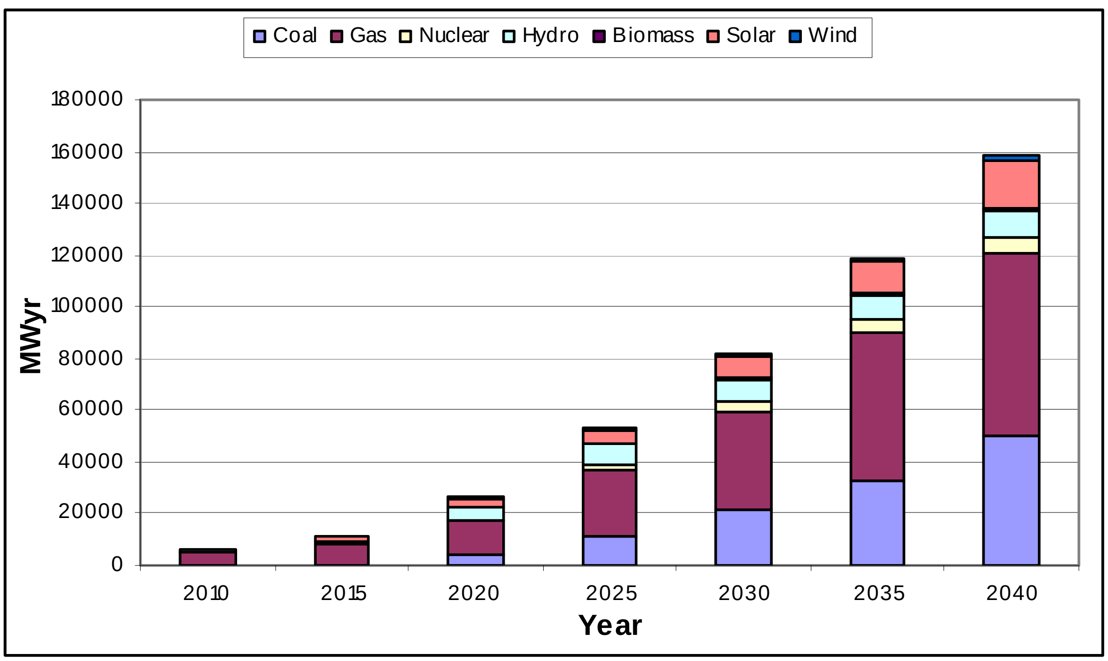


Fig 5.5: Electricity Supply projections by Source (Reference Scenario)

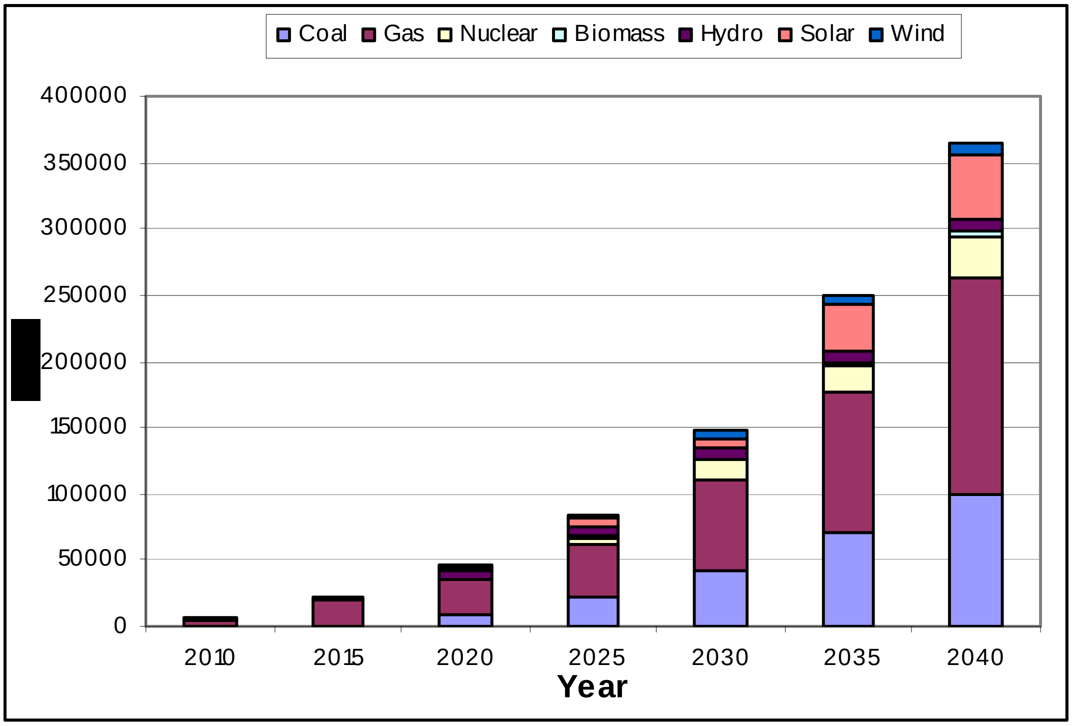


Fig. 5.6: Electricity Supply Projections by Source (High Growth Scenario)

The share of gas in the total electricity generation will decrease from 80% in 2010 to about 40% in 2040 for the two scenarios (Figures 5.7 & 5.8). Coal is assumed to be introduced in 2020 with 15% contribution and expected to increase to more than 30% of the total generation by 2040 for the reference scenario, whilst for the high growth scenario is less than 30%.

The share of hydro power will increase from about 17% in 2010 to 22% in 2020 and decline to less than 5% by the year 2040 for the reference scenario, as no addition hydro plant after reaching the hydro potential. Nuclear energy will be introduced by the year 2020 and the share of nuclear energy will increase steadily for the two scenarios.

Solar energy for electricity in Nigeria was providing vital services in other remote and off-grid rural locations in the country; this was largely via photovoltaic but was insignificant in terms of primary energy share. Solar power system mostly installed government institution with an installed capacity of almost 55MW. The share of solar energy will increase steadily for the reference and high growth scenarios.

Biomass energy is considered in this study, with the introduction of combined heat and power (CHP) plants based on biomass wastes to generate essentially steam for their operations and some amount of electricity to supplement their grid electricity supply. Also considered is the biodiesel for generation of electricity and will contribute about 2% of the total electricity for the two scenarios.

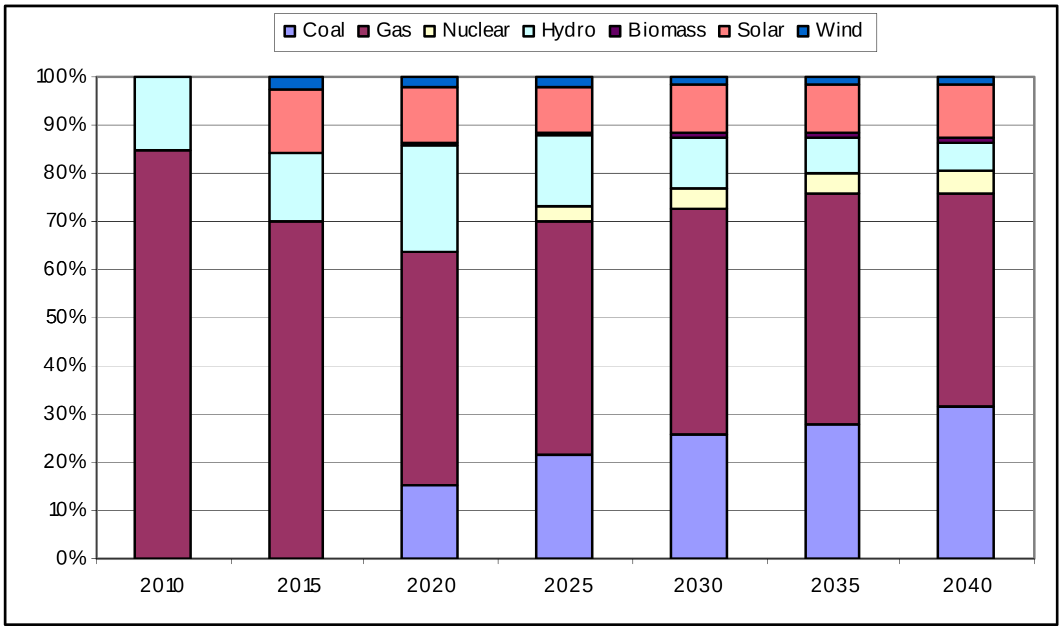


Fig. 5.7: Shares of Electricity Supply by Fuel Type (Reference Scenario)

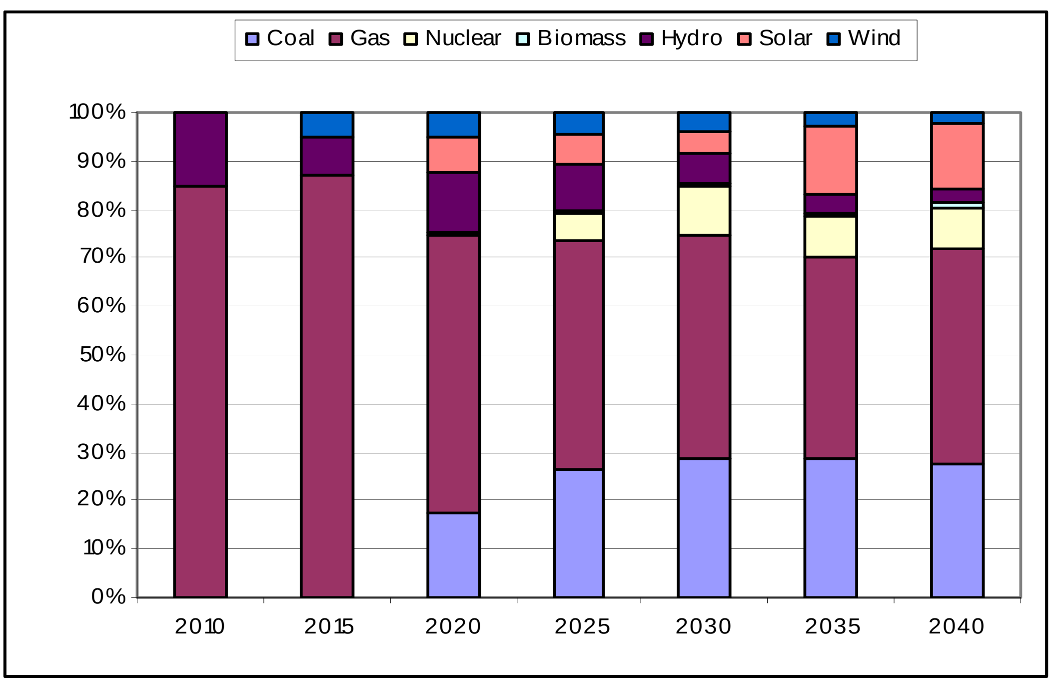


Fig. 5.8: Shares of Electricity Supply by Fuel Type (High Growth Scenario)

The electricity generations for the two scenarios are given in the appendixes III and IV. We assumed that all the on-going power plants i.e., the NIPPs and IPPs and the rehabilitation of the existing plant will be concluded. The new candidate plant are the sixteen CCGT, six GT and six coal fire plants, in addition to the new hydro, nuclear, wind and solar energies.

5.3.4 Transmission and Distribution

The transmission and distribution loss for the studies is 15%. In order to transmit and distribute the required generation efficiently there is need to expand the transmission and distribution infrastructure by:

- Enhancing supply reliability and improving voltage stability, since its capacity will be exceeded with growing load and additional power plants coming on line.
- Upgrading and expansion of transmission and distribution circuit
- Upgrading transmission system-wide reactive compensation capability.

5.3.5 Motor Fuel Projection

Estimates of the total crude oil reserves vary, but are generally accepted to be about 35 billion barrels, although new offshore discoveries are likely to push this figure to higher. In this study new discoveries are not included to avoid wrong predictions. The focus of the government's policy on the downstream sector can be summarized as follows:

- To maintain self-sufficiency in refining
- To ensure regular and uninterrupted domestic supply of all petroleum products at reasonable prices
- To establish infrastructure for the production of refined products for export.

Appendixes V and VI present the refinery production of the refined oil product projection for the reference and high growth scenarios respectively (see also Fig.5.9 & 5.10). There is continues importation of the refined product until 2020 when new refineries will be ready to supply the huge demand because of the transportation sector and the used of kerosene and fuel for heating purposed in the service and household sectors. Appendixes VII and VIII shows the installed capacity of the refineries for the reference and high growth scenarios, three categories of refineries are used in the study, existing refineries, green refineries and private refineries.

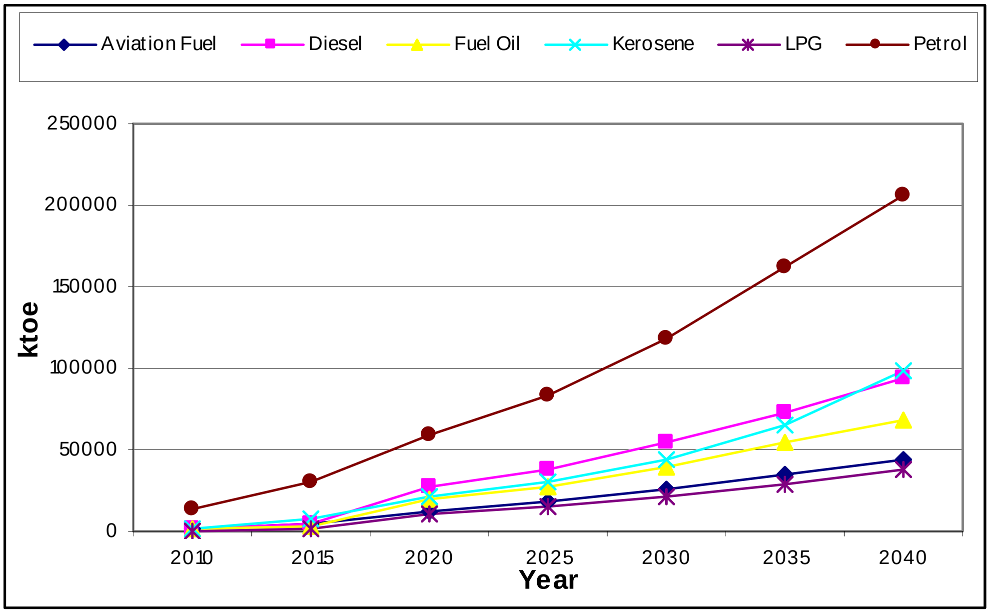


Fig. 5.9: Oil Product Supply Projections (Reference Scenario)

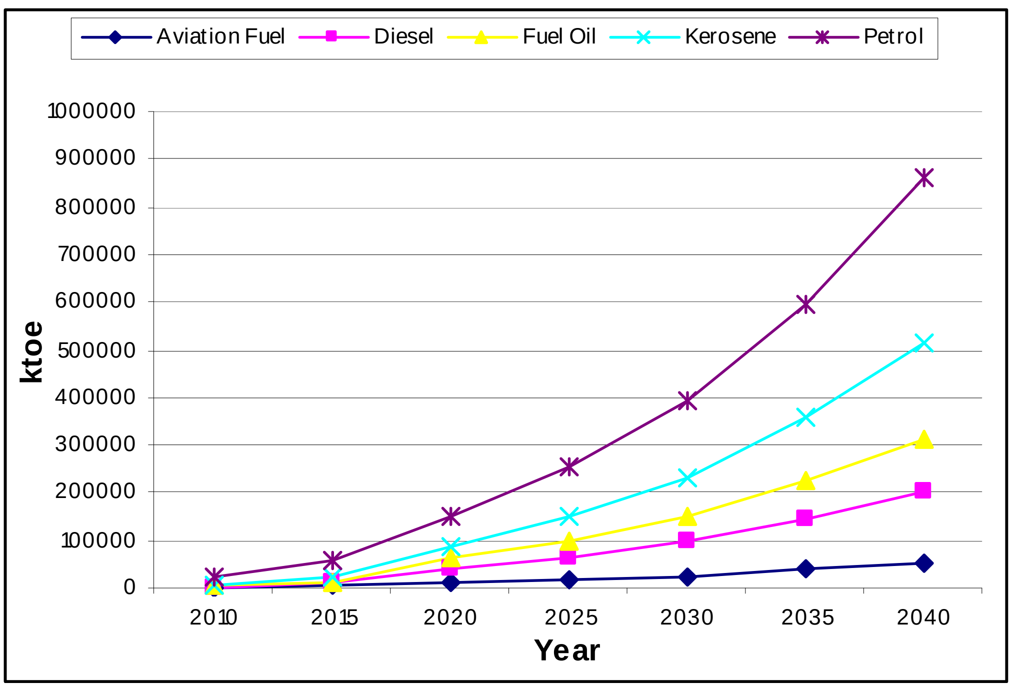


Fig. 5.10: Oil Product Supply Projections (High Growth Scenario)

The energy scenarios analyzed in this study indicate that:

- Natural gas is the most preferred fuel for electricity generation due to its higher efficiency of use and lower investments costs for combined cycle power plant. But, only limited quantity of gas from indigenous sources can be allocated to the power sector after meeting the essential requirement for non-power sector.
- The import of natural gas is an economic option and
- Maximum exploitation of hydro power, renewable energy and introduction of nuclear power are required as they are economical. Model selects whole of the allowed large and small hydro potential in its optimal solutions for all the scenarios.
- The Environmental benefits of hydro, nuclear and renewables have not been considered in the present study. Hydro, nuclear and renewables will be even more competitive if environmental benefits of theses options are considered.

CHAPTER SIX

6.0 CONCLUSION

The Vision 2020 Blueprint projected electricity generation capacity to increase to 35,000MW, although this was later upgraded to 40,000MW in the Power Sector Roadmap, which is the implementation plan for the actualization of the required electricity supply capacity for powering the Vision 2020 programmes. This is a significant improvement on the present situation in which the country produces only about 4,000MW. However, the 40,000MW will not be sufficient to realize Vision 2020, based on the analysis we have provided above. Electricity generation capacity of about 88,000MW, which is more than double the Power Sector Roadmap projection, would be required. It should also be realized that to consistently supply 88,000MW of electricity will require a capacity higher than that, in order to provide a reserve margin and take care of transmission and distribution losses.

Similarly, the planned petroleum refining capacities of 750,000 b/d by 2015 and 1,500,000 b/d by 2020 to be operational in Nigeria would not be sufficient to supply domestic requirements of energy petroleum products.

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APPENDICES

Appendix I: Electricity Installed Capacity in MW (Reference Scenario)

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
1	***Biomass_PP***	-	-	200	500	1,000	1,500	2,000
2	***Cap_Gas_Akute***	13	13	13	13	13	13	13
3	***Cap_Gas_CETPower1***	20	20	20	20	20	20	20
4	***Cap_Gas_CETPower2***	5	5	5	5	5	5	5
5	***Cap_Gas_Coronation***	20	20	20	20	20	20	20
6	***Cap_Solar_Wedotebary***	5	5	5	5	5	5	5
7	***CoalPP_I***	-	-	2,000	4,000	6,000	8,000	10,000
8	***CoalPP_II***	-	-	1,000	3,000	5,000	7,000	10,000
9	***CoalPP_III***	-	-	2,000	5,000	7,000	9,000	10,000
10	***CoalPP_IV***	-	-	-	2,000	5,000	7,000	10,000
11	***CoalPP_V***	-	-	-	-	3,000	6,000	10,000
12	***CoalPP_VI***	-	-	-	-	-	4,000	6,000
13	***CoalPP_VII***	-	-	-	-	-	-	6,000
14	***Exi_Gas_Afam***	956	776	776	776	555	527	527
15	***Exi_Gas_Delta***	822	822	392	395	395	395	395
16	***Exi_Gas_Egbin***	1,320	654	654	658	658	658	658
17	***Exi_Gas_Geregu1***	414	414	414	414	414	414	414
18	***Exi_Gas_Olurunsogo1***	335	335	335	335	335	335	335
19	***Exi_Gas_Omotosho1***	335	335	335	335	335	158	158
20	***Exi_Gas_Sapele***	131	131	131	132	132	132	132
21	***Exi_Hyd_Jebba***	540	540	540	540	540	540	540
22	***Exi_Hyd_Shiroro***	600	600	600	600	600	600	600
23	***Exi_Steam_Sapele***	392	392	392	395	395	395	395

24	***Exi_hyd_Kainji***	760	760	760	760	760	760	760
25	***GasPP_CCGT_III***	-	1,000	2,605	5,000	5,000	8,000	10,000
26	***GasPP_CCGT_IV***	-	-	3,000	5,000	7,000	8,000	10,000
27	***GasPP_CCGT_IX***	-	-	-	3,000	6,000	8,000	10,000
28	***GasPP_CCGT_V***	-	-	-	4,000	4,000	8,000	8,000
29	***GasPP_CCGT_VI***	-	-	-	4,000	4,000	8,000	8,000
30	***GasPP_CCGT_VII***	-	-	-	-	-	-	-
31	***GasPP_CCGT_VIII***	-	-	-	334	334	334	334
32	***GasPP_CCGT_X***	-	-	-	-	3,000	6,000	10,000
33	***GasPP_CCGT_XI***	-	-	-	-	4,000	7,000	10,000
34	***GasPP_CCGT_XII***	-	-	-	-	4,000	7,000	10,000
35	***GasPP_CCGT_XIII***	-	-	-	-	-	-	-
36	***IPP_Gas_AES***	270	270	270	270	158	158	158
37	***IPP_Gas_AgbaraShoreline***	-	56	56	56	56	56	56
38	***IPP_Gas_AnitaEnergy***	-	37	37	37	37	37	37
39	***IPP_Gas_DILPowe***	92	135	135	135	135	135	135
40	***IPP_Gas_ENCON***	105	140	140	140	140	140	140
41	***IPP_Gas_Geometric***	-	140	140	140	140	140	140
42	***IPP_Gas_Ethiope***	-	-	1,464	1,475	1,475	1,475	1,475
43	***IPP_Gas_FarmElectric***	-	-	78	79	79	79	79
44	***IPP_Gas_HudsonPower***	-	88	88	88	88	88	88
45	***IPP_Gas_ICSPower***	-	268	268	270	270	270	270
S/N	**Technologies**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
46	***IPP_Gas_IbafoPower***	-	111	111	112	112	112	112
47	***IPP_Gas_IbomPower***	190	190	190	190	190	190	190
48	***IPP_Gas_LotusBresson***	-	31	31	32	32	32	32

49	***IPP_Gas_MinajHolding***	98	115	115	115	115	115	115
50	***IPP_Gas_NotorePower***	33	50	50	50	50	50	50
51	***IPP_Gas_Okpai***	480	480	480	480	480	480	480
52	***IPP_Gas_Omoku***	150	150	150	150	150	150	150
53	***IPP_Gas_ParasEnergy***	62	96	96	96	96	96	96
54	***IPP_Gas_Shell_(AfamVI)***	642	642	642	642	642	642	642
55	***IPP_Gas_Supertek***	-	458	458	461	461	461	461
56	***IPP_Gas_TransAmadi***	136	136	136	136	136	136	136
57	***IPP_Gas_Westcom1***	-	458	458	461	461	461	461
58	***IPP_Hyd_Mabon***	-	39	39	39	39	39	39
59	***IPP_Hyd_NESCO***	30	30	30	30	30	30	30
60	***NIPP_Gas_Alaoji***	1,020	1,020	1,020	1,020	1,020	1,020	1,020
61	***NIPP_Gas_Calabar***	563	563	563	563	563	563	563
62	***NIPP_Gas_Egbema***	338	338	338	338	338	338	338
63	***NIPP_Gas_Gbarain***	225	225	225	225	225	225	225
64	***NIPP_Gas_Geregu2***	434	434	434	434	434	434	434
65	***NIPP_Gas_Ihovbor***	451	451	451	451	451	198	198
66	***NIPP_Gas_Olurunsogo2***	700	700	700	700	700	700	700
67	***NIPP_Gas_Omotosho2***	450	450	450	450	450	450	450
68	***NIPP_Gas_Sapele***	451	451	451	451	451	263	263
69	***NIPP_Hyd_Mambilla***	-	-	2,600	2,600	2,600	2,600	2,600
70	***NIPP_Hyd_Zungeru***	-	-	950	950	950	950	950
71	***NewHdr_PP_I***	-	-	1,950	1,950	1,950	1,950	1,950
72	***New_HdrPP_II***	-	-	-	1,050	1,050	1,050	1,050
73	***New_HdrPP_III***	-	-	-	1,500	1,500	1,500	1,500

74	***NuclPP_1***	-	-	-	1,488	2,480	4,031	4,961
75	***NuclPP_II***	-	-	-	-	1,860	2,480	3,721
76	***Small_Hyd***	62	175	667	1,289	2,560	3,834	5,101
77	***Solar_PV***	55	1,500	8,000	10,000	15,000	25,450	41,650
78	***SolarTherm_PP***	-	-	1,562	3,947	6,841	8,604	11,603
79	***Wind_Off_PP***	-	1,000	2,000	3,000	4,000	5,000	6,000
80	***Wind_PP***	-	500	1,000	2,000	3,000	3,000	3,000
	Total Install Capacity	***13,703***	***18,747***	***45,219***	***81,326***	***123,511***	***178,022***	***239,158***

Appendix II: Electricity Installed Capacity in MW (High Growth Scenario)

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
1	***Biomass_PP***	-	-	500	1,000	2,000	3,000	5,000
2	***Cap_Gas_Akute***	13	13	13	13	13	13	13
3	***Cap_Gas_CETPower1***	20	20	20	20	20	20	20
4	***Cap_Gas_CETPower2***	5	5	5	5	5	5	5
5	***Cap_Gas_Coronation***	20	20	20	20	20	20	20
6	***Cap_Solar_Wedotebary***	5	5	5	5	5	5	5
7	***CoalPP_I***	-	-	4,000	8,000	12,000	16,000	20,000
8	***CoalPP_II***	-	-	2,000	6,000	10,000	14,000	20,000
9	***CoalPP_III***	-	-	4,000	10,000	14,000	18,000	20,000
10	***CoalPP_IV***	-	-	-	4,000	10,000	14,000	20,000
11	***CoalPP_V***	-	-	-	-	6,000	12,000	20,000
12	***CoalPP_VI***	-	-	-	-	-	8,000	12,000
13	***CoalPP_VII***	-	-	-	-	-	6,000	12,000
14	***Exi_Gas_Afam***	956	960	960	960	960	960	960
15	***Exi_Gas_Delta***	822	822	395	395	822	822	822
16	***Exi_Gas_Egbin***	1,320	1,320	1,056	1,056	1,320	1,320	1,320
17	***Exi_Gas_Geregu1***	414	414	414	414	414	263	263
18	***Exi_Gas_Olurunsogo1***	335	335	335	335	335	335	335
19	***Exi_Gas_Omotosho1***	335	335	335	335	335	335	335
20	***Exi_Gas_Sapele***	131	300	300	300	300	300	300
21	***Exi_Hyd_Jebba***	540	540	540	540	540	540	540
22	***Exi_Hyd_Shiroro***	600	600	600	600	600	600	600
23	***Exi_Steam_Sapele***	392	720	720	720	720	720	720
24	***Exi_hyd_Kainji***	760	760	760	760	760	760	760

25	***GasPP_CCGT_I***	-	2,000	3,000	5,000	5,000	8,000	8,000
26	***GasPP_CCGT_II***	-	1,000	1,000	1,000	1,000	1,000	1,000
27	***GasPP_CCGT_III***	-	1,000	3,000	5,000	7,000	8,000	10,000
28	***GasPP_CCGT_IV***	-	-	3,000	5,000	7,000	8,000	10,000
29	***GasPP_CCGT_IX***	-	-	-	3,000	6,000	8,000	10,000
30	***GasPP_CCGT_V***	-	-	2,000	4,000	6,000	8,000	10,000
31	***GasPP_CCGT_VI***	-	-	2,000	4,000	6,000	8,000	10,000
32	***GasPP_CCGT_VII***	-	-	-	2,000	4,000	7,000	10,000
33	***GasPP_CCGT_VIII***	-	-	-	3,000	5,000	7,000	10,000
34	***GasPP_CCGT_X***	-	-	-	-	3,000	6,000	10,000
35	***GasPP_CCGT_XI***	-	-	-	-	4,000	7,000	10,000
36	***GasPP_CCGT_XII***	-	-	-	-	4,000	7,000	10,000
37	***GasPP_CCGT_XIII***	-	-	-	-	-	4,000	10,000
38	***GasPP_I***	-	1,000	1,000	5,000	7,000	9,000	10,000
39	***GasPP_II***	-	1,000	1,000	1,000	7,000	9,000	10,000
40	***GasPP_III***	-	-	-	-	-	-	-
41	***GasPP_IV***	-	-	-	-	4,000	8,000	10,000
42	***GasPP_V***	-	-	-	-	-	1,000	1,000
43	***GasPP_VI***	-	-	-	-	-	6,000	10,000
44	***IPP_Gas_AES***	270	270	270	270	270	270	270
45	***IPP_Gas_AgbaraShoreline***	-	56	56	56	56	56	56
46	***IPP_Gas_AnitaEnergy***	-	90	90	90	90	90	90
47	***IPP_Gas_DILPowe***	92	4,673	4,673	4,673	4,673	4,673	16,398
S/N	**Technologies**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
48	***IPP_Gas_ENCON***	105	140	140	140	140	140	140
49	***IPP_Gas_Eleme***	-	67	67	67	67	67	67

50	***IPP_Gas_Ethiope***	-	-	1,464	1,464	1,475	1,475	2,800
51	***IPP_Gas_FarmElectric***	-	-	79	79	79	79	150
52	***IPP_Gas_HudsonPower***	-	150	150	150	150	150	150
53	***IPP_Gas_ICSPower***	-	412	412	412	412	412	624
54	***IPP_Gas_IbafoPower***	-	200	200	200	200	200	200
55	***IPP_Gas_IbomPower***	190	190	190	190	190	190	190
56	***IPP_Gas_LotusBresson***	-	49	49	49	49	49	49
57	***IPP_Gas_MinajHolding***	98	115	115	115	115	115	115
58	***IPP_Gas_NotorePower***	33	1,251	1,251	1,251	1,251	9,063	9,031
59	***IPP_Gas_Okpai***	480	480	480	480	480	480	480
60	***IPP_Gas_Omoku***	150	150	150	150	150	150	150
61	***IPP_Gas_ParasEnergy***	62	96	96	96	96	96	25,013
62	***IPP_Gas_Shell_(AfamVI)***	642	642	642	642	642	642	642
63	***IPP_Gas_Supertek***	-	473	473	473	473	473	1,000
64	***IPP_Gas_TransAmadi***	136	136	136	136	136	136	136
65	***IPP_Gas_Westcom1***	-	1,000	1,000	1,000	1,000	1,000	1,000
66	***IPP_Hyd_Mabon***	-	-	39	39	39	39	39
67	***IPP_Hyd_NESCO***	30	30	30	30	30	30	30
68	***NIPP_Gas_Alaoji***	1,020	1,020	1,020	1,020	1,020	1,020	1,020
69	***NIPP_Gas_Calabar***	563	563	563	563	563	563	563
70	***NIPP_Gas_Egbema***	338	338	338	338	338	338	338
71	***NIPP_Gas_Gbarain***	225	225	225	225	225	225	225
72	***NIPP_Gas_Geregu2***	434	434	434	434	434	434	434
73	***NIPP_Gas_Ihovbor***	451	451	451	451	451	451	451
74	***NIPP_Gas_Olurunsogo2***	700	700	700	700	700	700	700

75	***NIPP_Gas_Omotosho2***	450	450	450	450	450	450	450
76	***NIPP_Gas_Sapele***	451	451	451	451	451	451	451
77	***NIPP_Hyd_Mambilla***	-	-	2,600	2,600	2,600	2,600	2,600
78	***NIPP_Hyd_Zungeru***	-	-	950	950	950	950	950
79	***NewHdr_PP_I***	-	-	1,950	1,950	1,950	1,950	1,950
80	***New_HdrPP_II***	-	-	-	1,050	1,050	1,050	1,050
81	***New_HdrPP_III***	-	-	-	1,500	1,500	1,500	1,500
82	***NuclPP_1***	-	-	-	6,000	10,000	15,000	20,000
83	***NuclPP_II***	-	-	-	-	8,000	10,000	20,000
84	***Small_Hyd***	62	175	667	1,289	2,560	3,834	5,101
85	***Solar_PV***	55	2,000	15,000	30,000	50,000	100,000	130,000
86	***SolarTherm_PP***	-	-	5,000	7,500	10,000	15,000	25,000
87	***Wind_Off_PP***	-	1,500	3,000	5,000	7,000	8,500	10,000
88	***Wind_PP***	-	1,000	2,500	4,000	6,000	8,000	10,000
	Total Install Capacity	***13,703***	***33,146***	***81,529***	***152,201***	***255,674***	***411,110***	***587,622***

Appendix III: Electricity Production projection in MWyr (Reference Scenario)

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
1	***Exi_hyd_Kainji***	350	581	581	581	581	581	581
2	***Exi_Hyd_Jebba***	250	437	437	437	437	437	437
3	***Exi_Hyd_Shiroro***	320	486	486	486	486	486	486
4	***Exi_Gas_Afam***	400	400	412	413	404	403	403
5	***Exi_Gas_Egbin***	500	500	500	504	504	504	504
6	***Exi_Gas_Sapele***	100	100	100	101	101	101	101
7	***Exi_Steam_Sapele***	300	300	300	302	302	302	302
8	***Exi_Gas_Delta***	300	317	300	302	302	302	302
9	***Exi_Gas_Geregu1***	200	200	200	200	200	200	200
10	***Exi_Gas_Omotosho1***	120	120	124	138	127	121	121
11	***Exi_Gas_Olurunsogo1***	120	120	124	138	127	121	121
13	***NIPP_Gas_Alaoji***	450	538	488	468	468	453	453
14	***NIPP_Gas_Ihovbor***	150	176	160	160	160	151	151
15	***NIPP_Gas_Gbarain***	100	104	106	104	104	101	101
16	***NIPP_Gas_Egbema***	170	194	179	175	175	171	171
17	***NIPP_Gas_Calabar***	300	342	321	308	308	302	302
18	***NIPP_Gas_Sapele***	200	225	221	208	208	201	201
19	***NIPP_Gas_Olurunsogo2***	320	536	535	536	536	536	535
20	***NIPP_Gas_Omotosho2***	230	344	344	344	344	344	344
21	***NIPP_Gas_Geregu2***	200	332	332	332	332	332	332
22	***NIPP_Hyd_Zungeru***	-	-	727	727	727	727	727
23	***NIPP_Hyd_Mambilla***	-	-	1,768	1,768	1,768	1,768	1,768
24	***IPP_Gas_Shell_(AfamVI)***	250	257	260	283	263	252	252

25	IPP_Gas_IbomPower	80	92	84	84	84	82	81
26	IPP_Gas_Omoku	40	40	40	44	44	42	40
27	IPP_Gas_TransAmadi	50	51	50	57	53	51	50
28	IPP_Gas_Geometric	-	95	95	95	95	95	95
29	IPP_Gas_AES	120	153	132	125	121	121	121
30	IPP_Gas_Okpai	200	205	209	228	209	202	201
31	IPP_Gas_Ethiope	-	-	1,120	1,128	1,128	1,128	1,128
32	IPP_Gas_FarmElectric	-	-	60	60	60	60	60
33	IPP_Gas_ICSPower	-	205	205	206	206	206	206
34	IPP_Gas_Supertek	-	350	350	353	353	353	353
35	IPP_Gas_Westcom1	-	350	350	353	353	353	353
36	IPP_Gas_LotusBresson	-	24	24	24	24	24	24
37	IPP_Gas_AnitaEnergy	-	28	28	28	28	28	28
38	IPP_Gas_HudsonPower	-	67	67	67	67	67	67
39	IPP_Gas_IbafoPower	-	85	85	86	86	86	86
40	IPP_Gas_AgbaraShoreline	-	38	38	38	38	38	38
41	IPP_Gas_ENCON/Electricity	80	80	82	85	82	82	82
42	IPP_Gas_MinajHolding	75	75	76	78	76	76	76
43	IPP_Gas_NotorePower	25	25	26	27	26	26	26
S/N	**Technologies**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
44	IPP_Gas_DILPower	70	70	72	75	72	72	72
45	IPP_Gas_ParasEnergy	50	50	51	54	51	51	51
46	Cap_Gas_Akute	8	8	8	8	8	8	8
47	IPP_Hyd_NESCO	10	24	24	24	24	24	24
48	IPP_Hyd_Mabon	-	-	5	5	5	5	5

49	***GasPP_CCGT_III***	-	810	2,110	4,050	4,050	6,480	8,100
50	***GasPP_CCGT_IV***	-	-	2,430	4,050	5,670	6,480	8,100
51	***GasPP_CCGT_V***	-	-	-	3,240	3,240	6,480	6,480
52	***GasPP_CCGT_VI***	-	-	-	3,240	3,240	6,480	6,480
53	***GasPP_CCGT_VIII***	-	-	-	270	270	270	270
54	***GasPP_CCGT_IX***	-	-	-	2,430	4,860	6,480	8,100
55	***GasPP_CCGT_X***	-	-	-	-	2,430	4,860	8,100
56	***GasPP_CCGT_XI***	-	-	-	-	3,240	5,670	8,100
57	***GasPP_CCGT_XII***	-	-	-	-	3,240	5,670	8,100
58	***NewHdr_PP_I***	-	-	1,316	1,316	1,316	1,316	1,316
59	***New_HdrPP_II***	-	-	-	709	709	709	709
60	***New_HdrPP_III***	-	-	-	1,013	1,013	1,013	1,013
61	***Small_Hyd***	-	118	450	870	1,728	2,588	3,443
62	***CoalPP_I***	-	-	1,620	3,240	4,860	6,480	8,100
63	***CoalPP_II***	-	-	810	2,430	4,050	5,670	8,100
64	***CoalPP_III***	-	-	1,620	4,050	5,670	7,290	8,100
65	***CoalPP_IV***	-	-	-	1,620	4,050	5,670	8,100
66	***CoalPP_V***	-	-	-	-	2,430	4,860	8,100
67	***CoalPP_VI***	-	-	-	-	-	3,240	4,860
68	***CoalPP_VII***	-	-	-	-	-	-	4,860
69	***NuclPP_1***	-	-	-	1,205	2,009	3,265	4,018
70	***NuclPP_II***	-	-	-	-	1,507	2,009	3,014
71	***SolarTherm_PP***	-	-	1,000	2,526	4,378	5,506	7,426
72	***Wind_PP***	-	60	100	250	400	550	608
73	***Wind_Off_PP***	-	250	500	750	1,000	1,250	1,500

74	***Biomass_PP***	-	-	135	338	675	1,013	1,350
75	***Cap_Gas_CETPower1***	10	16	16	11	10	16	12
76	***Cap_Gas_CETPower2***	3	4	4	3	3	3	3
77	***Cap_Gas_Coronation***	10	6,873	6,499	6,275	4,162	1,800	1,216
78	***Cap_Solar_Wedotebary***	-	1	1	1	1	1	1
79	***Solar_PV***	1	375	2,000	2,500	3,750	6,363	10,413
	Total	***6,161***	***17,232***	***32,898***	***58,736***	***86,220***	***121,659***	***160,263***

Appendix IV: Electricity Production projection in MWyr (High Growth Scenario)

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
1	***Exi_hyd_Kainji***	350	581	581	581	581	581	581
2	***Exi_Hyd_Jebba***	250	437	437	437	437	437	437
3	***Exi_Hyd_Shiroro***	320	486	486	486	486	486	486
4	***Exi_Gas_Afam***	400	508	500	417	418	421	441
5	***Exi_Gas_Egbin***	500	1,010	808	538	527	531	1,010
6	***Exi_Gas_Sapele***	100	230	230	121	107	108	230
7	***Exi_Steam_Sapele***	300	551	551	343	323	316	551
8	***Exi_Gas_Delta***	300	629	302	300	317	320	585
9	***Exi_Gas_Geregu1***	200	207	200	200	207	201	201
10	***Exi_Gas_Omotosho1***	120	256	256	145	138	128	256
11	***Exi_Gas_Olurunsogo1***	120	256	256	145	138	128	256
13	***NIPP_Gas_Alaoji***	450	780	780	780	497	780	780
14	***NIPP_Gas_Ihovbor***	150	345	345	345	176	345	345
15	***NIPP_Gas_Gbarain***	100	172	172	172	110	172	172
16	***NIPP_Gas_Egbema***	170	259	259	259	183	259	259
17	***NIPP_Gas_Calabar***	300	431	431	431	321	431	431
18	***NIPP_Gas_Sapele***	200	345	345	345	224	345	345
19	***NIPP_Gas_Olurunsogo2***	320	536	535	536	536	535	536
20	***NIPP_Gas_Omotosho2***	230	344	344	344	344	344	344
21	***NIPP_Gas_Geregu2***	200	332	332	332	332	332	332
22	***NIPP_Hyd_Zungeru***	-	-	727	727	727	727	727
23	***NIPP_Hyd_Mambilla***	-	-	1,768	1,768	1,768	1,768	1,768
24	***IPP_Gas_Shell_(AfamVI)***	250	491	491	276	283	265	491
25	***IPP_Gas_IbomPower***	80	145	145	145	89	145	145

26	IPP_Gas_Omoku	40	44	44	40	44	44	44
27	IPP_Gas_TransAmadi	50	104	104	56	57	53	104
28	IPP_Gas_Gemetric	-	95	95	95	95	95	95
29	IPP_Gas_AES	120	207	207	207	132	207	207
30	IPP_Gas_Okpai	200	367	367	230	223	211	367
31	IPP_Gas_Ethiope	-	-	1,120	1,120	1,128	1,128	2,111
32	IPP_Gas_FarmElectric	-	-	60	60	60	60	81
33	IPP_Gas_ICSPower	-	231	229	205	212	223	477
34	IPP_Gas_Supertek	-	362	362	353	353	358	726
35	IPP_Gas_Westcom1	-	658	558	405	372	375	381
36	IPP_Gas_LotusBresson	-	38	35	26	25	25	26
37	IPP_Gas_AnitaEnergy	-	46	65	29	30	30	33
38	IPP_Gas_HudsonPower	-	94	101	70	70	70	72
39	IPP_Gas_IbafoPower	-	125	141	89	89	89	93
40	IPP_Gas_AgbaraShoreline	-	38	38	38	38	38	38
41	IPP_Gas_ENCON/Electricity	80	91	90	82	82	82	84
42	IPP_Gas_MinajHolding	75	82	81	77	76	76	78
43	IPP_Gas_NotorePower	25	950	342	94	68	694	743
44	IPP_Gas_DILPower	70	3,575	2,634	236	233	254	1,766
45	IPP_Gas_ParasEnergy	50	78	78	55	54	54	20,261
46	Cap_Gas_Akute	8	11	11	11	8	11	11
47	IPP_Hyd_NESCO	10	24	24	24	24	24	24
S/N	**Technologies**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
48	IPP_Hyd_Mabon	-	-	32	32	32	32	32
49	GasPP_CCGT_I	-	1,260	2,500	3,500	4,000	6,000	6,000

50	***GasPP_CCGT_II***	-	810	810	810	810	810	810
51	***GasPP_CCGT_III***	-	810	2,430	4,050	5,670	6,480	8,100
52	***GasPP_CCGT_IV***	-	-	2,430	4,050	5,670	6,480	8,100
53	***GasPP_CCGT_V***	-	-	1,620	3,240	4,860	6,480	8,100
54	***GasPP_CCGT_VI***	-	-	1,620	3,240	4,860	6,480	8,100
55	***GasPP_CCGT_VII***	-	-	-	1,620	3,240	5,670	8,100
56	***GasPP_CCGT_VIII***	-	-	-	2,430	4,050	5,670	8,100
57	***GasPP_CCGT_IX***	-	-	-	2,430	4,860	6,480	8,100
58	***GasPP_CCGT_X***	-	-	-	-	2,430	4,860	8,100
59	***GasPP_CCGT_XI***	-	-	-	-	3,240	5,670	8,100
60	***GasPP_CCGT_XII***	-	-	-	-	3,240	5,670	8,100
61	***GasPP_CCGT_XIII***	-	-	-	-	-	3,240	8,100
62	***GasPP_I***	-	810	810	4,050	5,670	7,290	8,100
63	***GasPP_II***	-	720	720	720	4,721	6,480	7,200
64	***GasPP_IV***	-	-	-	-	2,670	5,760	7,200
65	***GasPP_V***	-	-	-	-	-	720	720
66	***GasPP_VI***	-	-	-	-	-	4,320	7,200
67	***NewHdr_PP_I***	-	-	1,316	1,316	1,316	1,316	1,316
68	***New_HdrPP_II***	-	-	-	709	709	709	709
69	***New_HdrPP_III***	-	-	-	1,013	1,013	1,013	1,013
70	***Small_Hyd***	-	118	450	870	1,728	2,588	3,443
71	***CoalPP_I***	-	-	3,240	6,480	9,720	12,960	16,200
72	***CoalPP_II***	-	-	1,620	4,860	8,100	11,340	16,200
73	***CoalPP_III***	-	-	3,240	8,100	11,340	14,580	16,200
74	***CoalPP_IV***	-	-	-	3,240	8,100	11,340	16,200

75	***CoalPP_V***	-	-	-	-	4,860	9,720	16,200
76	***CoalPP_VI***	-	-	-	-	-	6,480	9,720
77	***CoalPP_VII***	-	-	-	-	-	4,860	9,720
78	***NuclPP_1***	-	-	-	4,860	8,100	12,150	16,200
79	***NuclPP_II***	-	-	-	-	6,480	8,100	16,200
80	***SolarTherm_PP***	-	-	3,200	4,800	6,400	9,600	16,000
81	***Wind_PP***	-	450	1,125	1,800	2,700	3,600	4,500
82	***Wind_Off_PP***	-	675	1,350	2,250	3,150	3,825	4,500
83	***Biomass_PP***	-	-	300	600	1,200	1,800	3,000
84	***Cap_Gas_CETPower1***	10	16	16	16	16	16	16
85	***Cap_Gas_CETPower2***	3	4	4	4	4	4	4
86	***Cap_Gas_Coronation***	10	16	16	16	16	16	16
87	***Cap_Solar_Wedotebary***	-	1	1	1	1	1	1
88	***Solar_PV***	1	39	119	236	394	25,000	32,500
	Total	***6,161***	***22,280***	***47,038***	***85,117***	***148,111***	***249,918***	***365,751***

Appendix V: Production of Refined Oil Product in ktoe (Reference Scenario)

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
1	***Kad_Ref/Aviation_Fuel***	159	413	413	413	413	413	413
2	***Warri_Ref/Aviation_Fuel***	191	445	445	445	445	445	445
3	***Port_Ref/Aviation_Fuel***	191	772	772	772	772	772	772
4	***Green_Ref_Lokoja/Aviation_Fuel***	-	-	923	923	923	923	923
5	***Green_Ref_Lagos/Aviation_Fuel***	-	-	923	923	923	923	923
6	***Green_Ref_Bayelsa/Aviation_Fuel***	-	-	923	923	923	923	923
7	***Private_Ref/Aviation_Fuel***	-	-	8,180	13,359	20,811	29,859	39,361
8	***Aviation_Fuel_Import***	497	2,214	-	-	-	-	-
	Total Aviation Fuel	***1,037***	***3,843***	***12,579***	***17,758***	***25,210***	***34,258***	***43,761***
9	***Kad_Ref/Diesel***	340	885	885	885	885	885	885
10	***Warri_Ref/Diesel***	408	953	953	953	953	953	953
11	***Port_Ref/Diesel***	408	1,654	1,654	1,654	1,654	1,654	1,654
12	***Green_Ref_Lokoja/Diesel***	-	-	1,979	1,979	1,979	1,979	1,979
13	***Green_Ref_Lagos/Diesel***	-	-	1,979	1,979	1,979	1,979	1,979
14	***Green_Ref_Bayelsa/Diesel***	-	-	1,979	1,979	1,979	1,979	1,979
15	***Private_Ref/Diesel***	-	-	17,528	28,627	44,595	63,983	84,345
16	***Diesel_Import/Diesel***	235	698	-	-	-	-	-
	Total Diesel	***1,392***	***4,190***	***26,955***	***38,054***	***54,022***	***73,411***	***93,773***
17	***Kad_Ref/Fuel_Oil***	250	649	649	649	649	649	649
18	***Warri_Ref/Fuel_Oil***	299	699	699	699	699	699	699
19	***Port_Ref/Fuel_Oil***	299	1,213	1,213	1,213	1,213	1,213	1,213
20	***Green_Ref_Lokoja/Fuel_Oil***	-	-	1,451	1,451	1,451	1,451	1,451
21	***Green_Ref_Lagos/Fuel_Oil***	-	-	1,451	1,451	1,451	1,451	1,451
22	***Green_Ref_Bayelsa/Fuel_Oil***	-	-					

				1,451	1,451	1,451	1,451	1,451
23	***Private_Ref/Fuel_Oil***	-	-	12,854	20,993	32,703	46,921	61,853
24	***Fuel_Oil_Import/Fuel_Oil***	-	-	-	-	-	-	-
	Total Fuel Oil	***849***	***2,561***	***19,767***	***27,906***	***39,616***	***53,835***	***68,767***
25	***Kad_Ref/Kerosene***	272	708	708	708	708	708	708
26	***Warri_Ref/Kerosene***	327	762	762	762	762	762	762
27	***Port_Ref/Kerosene***	327	1,323	1,323	1,323	1,323	1,323	1,323
28	***Green_Ref_Lokoja/Kerosene***	-	-	1,583	1,583	1,583	1,583	1,583
29	***Green_Ref_Lagos/Kerosene***	-	-	1,583	1,583	1,583	1,583	1,583
30	***Green_Ref_Bayelsa/Kerosene***	-	-	1,583	1,583	1,583	1,583	1,583
31	***Private_Ref/Kerosene***	-	-	14,022	22,901	35,676	51,187	67,476
32	***Kerosene_Import/Kerosene***	-	4,085	-	-	-	6,505	23,539
	Total Kerosene	***926***	***6,879***	***21,564***	***30,443***	***43,217***	***65,234***	***98,557***
33	***Kad_Ref/LPG***	136	354	354	354	354	354	354
34	***Warri_Ref/LPG***	163	381	381	381	381	381	381
35	***Port_Ref/LPG***	163	662	662	662	662	662	662
36	***Green_Ref_Lokoja/LPG***	-	-	791	791	791	791	791
37	***Green_Ref_Lagos/LPG***	-	-	791	791	791	791	791
38	***Green_Ref_Bayelsa/LPG***	-	-	791	791	791	791	791
39	***Private_Ref/LPG***	-	-	7,011	11,451	17,838	25,593	33,738
40	***LPG_Import/LPG***	-	-	-	-	-	-	-
	Total LPG	***463***	***1,397***	***10,782***	***15,222***	***21,609***	***29,364***	***37,509***
41	***Kad_Ref/Petrol***	749	1,947	1,947	1,947	1,947	1,947	1,947
S/N	**Technologies**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
42	***Warri_Ref/Petrol***	898	2,096	2,096	2,096	2,096	2,096	2,096
43	***Port_Ref/Petrol***	898	3,639	3,639	3,639	3,639	3,639	3,639
44	***Green_Ref_Lokoja/Petrol***	-	-	4,353	4,353	4,353	4,353	4,353

45	***Green_Ref_Lagos/Petrol***	-	-	4,353	4,353	4,353	4,353	4,353
46	***Green_Ref_Bayelsa/Petrol***	-	-	4,353	4,353	4,353	4,353	4,353
47	***Private_Ref/Petrol***	-	-	38,561	62,978	98,108	140,764	185,560
48	***Petrol_Import/Petrol***	10,464	22,758	-	-	-	-	-
	Total Petrol	***13,009***	***30,440***	***59,301***	***83,719***	***118,848***	***161,504***	***206,300***

Appendix VI: Production of Refined Oil Product in ktoe (High growth Scenario)

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
1	***Kad_Ref/Aviation_Fuel***	159	413	413	413	413	413	413
2	***Warri_Ref/Aviation_Fuel***	191	445	445	445	445	445	445
3	***Port_Ref/Aviation_Fuel***	191	772	772	772	772	772	772
4	***Green_Ref_Lokoja/Aviation_Fuel***	0	0	923	923	923	923	923
5	***Green_Ref_Lagos/Aviation_Fuel***	0	0	923	923	923	923	923
6	***Green_Ref_Bayelsa/Aviation_Fuel***	0	0	923	923	923	923	923
7	***Private_Ref/Aviation_Fuel***	0	0	9319	17825	29544	46151	65176
8	***Aviation_Fuel_Import***	760	3348	0	0	0	0	0
	Total Aviation Fuel	***1300***	***4977***	***13719***	***22224***	***33943***	***50550***	***69576***
9	***Kad_Ref/Diesel***	340	885	885	885	885	885	885
10	***Warri_Ref/Diesel***	408	953	953	953	953	953	953
11	***Port_Ref/Diesel***	408	1654	1654	1654	1654	1654	1654
12	***Green_Ref_Lokoja/Diesel***	0	0	1979	1979	1979	1979	1979
13	***Green_Ref_Lagos/Diesel***	0	0	1979	1979	1979	1979	1979
14	***Green_Ref_Bayelsa/Diesel***	0	0	1979	1979	1979	1979	1979
15	***Private_Ref/Diesel***	0	0	19970	38196	63308	98894	139664
16	***Diesel_Import/Diesel***	622	1853	0	0	0	0	0
	Total Diesel	***1779***	***5344***	***29398***	***47624***	***72735***	***108322***	***149091***
17	***Kad_Ref/Fuel_Oil***	250	649	649	649	649	649	649
18	***Warri_Ref/Fuel_Oil***	299	699	699	699	699	699	699
19	***Port_Ref/Fuel_Oil***	299	1213	1213	1213	1213	1213	1213
20	***Green_Ref_Lokoja/Fuel_Oil***	0	0	1451	1451	1451	1451	1451
21	***Green_Ref_Lagos/Fuel_Oil***	0	0	1451	1451	1451	1451	1451
22	***Green_Ref_Bayelsa/Fuel_Oil***	0	0	1451	1451	1451	1451	1451
23	***Private_Ref/Fuel_Oil***	0	0	14645	28011	46426	72523	102420
24	***Fuel_Oil_Import/Fuel_Oil***	0	813	0	0	0	0	0
	Total Fuel Oil	***849***	***3373***	***21558***	***34924***	***53339***	***79436***	***109333***
25	***Kad_Ref/Kerosene***	272	708	708	708	708	708	708
26	***Warri_Ref/Kerosene***	327	762	762	762	762	762	762
27	***Port_Ref/Kerosene***	327	1323	1323	1323	1323	1323	1323
28	***Green_Ref_Lokoja/Kerosene***	0	0	1583	1583	1583	1583	1583
29	***Green_Ref_Lagos/Kerosene***	0	0	1583	1583	1583	1583	1583
30	***Green_Ref_Bayelsa/Kerosene***	0	0	1583	1583	1583	1583	1583
31	***Private_Ref/Kerosene***	0	0	15976	30557	50646	79116	111731
32	***Kerosene_Import/Kerosene***	231	6830	3257	10847	23458	44291	85382
	Total Kerosene	***1157***	***9623***	***26775***	***48946***	***81646***	***130948***	***204655***
33	***Kad_Ref/LPG***	136	354	354	354	354	354	354
34	***Warri_Ref/LPG***	163	381	381	381	381	381	381
35	***Port_Ref/LPG***	163	662	662	662	662	662	662
36	***Green_Ref_Lokoja/LPG***	0	0	791	791	791	791	791
37	***Green_Ref_Lagos/LPG***	0	0	791	791	791	791	791
38	***Green_Ref_Bayelsa/LPG***	0	0	791	791	791	791	791
39	***Private_Ref/LPG***	0	0	7988	15279	25323	39558	55865
40	***LPG_Import/LPG***	0	0	0	0	0	0	0
	Total LPG	***463***	***1397***	***11759***	***19049***	***29094***	***43329***	***59636***
41	***Kad_Ref/Petrol***	749	1947	1947	1947	1947	1947	1947

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
42	***Warri_Ref/Petrol***	898	2096	2096	2096	2096	2096	2096
43	***Port_Ref/Petrol***	898	3639	3639	3639	3639	3639	3639
44	***Green_Ref_Lokoja/Petrol***	0	0	4353	4353	4353	4353	4353
45	***Green_Ref_Lagos/Petrol***	0	0	4353	4353	4353	4353	4353
46	***Green_Ref_Bayelsa/Petrol***	0	0	4353	4353	4353	4353	4353
47	***Private_Ref/Petrol***	0	0	43935	84032	139277	217568	307260
48	***Petrol_Import/Petrol***	13222	27879	0	0	0	0	15129
	Total Petrol	***15767***	***35561***	***64675***	***104772***	***160017***	***238308***	***343129***

Appendix VII: Refinery Installed Capacity in bbl per day (Reference Scenario)

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
1	***Green_Ref_Bayelsa***	-	-	257,162	257,162	257,162	257,162	257,162
2	***Green_Ref_Lagos***	-	-	257,162	257,162	257,162	257,162	257,162
3	***Green_Ref_Lokoja***	-	-	257,162	257,162	257,162	257,162	257,162
4	***Kad_Ref***	110,429	110,429	110,429	110,429	110,429	110,429	110,429
5	***Port_Ref***	204,217	204,217	204,217	204,217	204,217	204,217	204,217
6	***Private_Ref***	-	-	2,278,156	3,720,701	5,796,108	8,316,148	10,962,652
7	***Warri_Ref***	121,018	121,018	121,018	121,018	121,018	121,018	121,018
	Total	***435,663***	***435,663***	***3,485,307***	***4,927,852***	***7,003,258***	***9,523,299***	***12,169,802***

Appendix VIII: Refinery Installed Capacity in bbl per day (High Growth Scenario)

S/N	Technologies	2010	2015	2020	2025	2030	2035	2040
1	***Green_Ref_Bayelsa***	-	-	257,162	257,162	257,162	257,162	257,162
2	***Green_Ref_Lagos***	-	-	257,162	257,162	257,162	257,162	257,162
3	***Green_Ref_Lokoja***	-	-	257,162	257,162	257,162	257,162	257,162
4	***Kad_Ref***	110,429	110,429	110,429	110,429	110,429	110,429	110,429
5	***Port_Ref***	204,217	204,217	204,217	204,217	204,217	204,217	204,217
6	***Private_Ref***	-	-	2,595,616	4,964,505	8,228,327	12,853,657	18,152,640
7	***Warri_Ref***	121,018	121,018	121,018	121,018	121,018	121,018	121,018
	Total	***435,663***	***435,663***	***3,802,766***	***6,171,656***	***9,435,478***	***14,060,808***	***19,359,791***