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The Nigerian Energy Sector

An Overview with a Special Emphasis on Renewable Energy, Energy Efficiency and Rural Electrification

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List of Abbreviations

Acronym	Definition
AADL	Allied Atlantic Distilleries Ltd.
AC	Alternating Current
AFD	Agence Française de Développement (French Development Agency)
ANSEP	Association of Nigerian Solar Energy Promoters
APC	All Progressives Congress
ARECON	Association of Rural Electrification Contractors of Nigeria (Renewable and Rural Power Department)
ATC&C	Aggregate Technical, Commercial and Collection
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
BPE	Bureau of Public Enterprise
BPP	Bureau of Public Procurement
CCGT	Combined Cycle Gas Turbine
CCN	Climate Change Network
CCTV	Closed Circuit Television
CDM	Clean Development Mechanism
CEO	Chief Executing Officer
CFC	Chlorofluorocarbon
CFL	Compact Fluorescent Lamp
CNG	Compressed Natural Gas
CREDC	Community Research and Development Centre
CREN	Council for Renewable Energy
CSP	Concentrated Solar Power
DC	Direct Current
DCC	Department of Climate Change
DFI	Development Financing Institution
DFID	Department for International Development
DISCO	Distribution Company
DNI	Direct Normal Irradiation
DPR	Detailed Project Report
ECN	Energy Commission of Nigeria
ECOWAS	Economic Community of West African States
EE	Energy Efficiency
EEB	Energy Efficiency in Buildings
EG	Embedded generation
EIA	Energy Information Agency
EIA	Environmental Impact Assessment
EIS	Electrical Inspectorate Services (former Department of FMP)
EIU	Economist Intelligence Unit
ELPS	Escravos Lagos Pipeline Systems
EMAS	Eco-Management and Audit Scheme
EMIS	Energy Management and Information Systems
EMS	Electricity Management Services Limited
EPC	Engineering, Procurement and Construction
EPIC	Electrical Power Implementation Committee
EPSR	Electricity Power Sector Reform
EPSRA	Electricity Power Sector Reform Act
ESIA	Environmental and Social Impact Assessment
ESMAP	Energy Sector Management Assistance Program
FCT	Federal Capital Territory (Abuja)
FEC	Federal Executive Council
FGN	Federal Government of Nigeria
FHA	Federal Housing Authority
FIPA	Foreign Investment Forum Promotion and Protection Agreement
FIT	Feed-in Tariff
FMBN	Federal Mortgage Bank of Nigeria
FMENV	Federal Ministry of Environment

FMLHUD	Federal Ministry of Land, Housing and Urban Development
FMP	Federal Ministry of Power
FMST	Federal Ministry of Science and Technology
FMITI	Federal Ministry of Industry, Trade and Investment
FMWR	Federal Ministry of Water Resources
FOB	Free On Board
GACN	Gas Aggregation Company of Nigeria
GBCN	Green Building Council of Nigeria
GDP	Gross Domestic Product
GE	General Electric
GEF	Global Environmental Fund
GENCO	Generation Company
GHI	Global Horizontal Irradiation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Agency for International Cooperation)
GOPA-intec	GOPA-International Energy Consultants GmbH
GTI	Global Tilted Irradiation
HCFC	Hydrochlorofluorocarbon
hh	households
hhK	household kerosene
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
IBRD	International Bank for Reconstruction and Development
ICEED	International Centre for Energy, Environment and Development
ICRC	Infrastructure Concession and Regulatory Commission
ICREEE	Inter-Ministerial Committee on Renewable Energy and Energy Efficiency
IDA	International Development Association
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEDN	Independent Electricity Distribution Networks
IFC	International Finance Corporation
IMF	International Monetary Fund
IOC	International Oil Companies
IPP	Independent Power Producer
ISO	International Organisation for Standardization
JICA	Japan International Cooperation Agency
ktoe	Kilo Tons of Oil Equivalent
KSPP	Karshi Solar Panel Plant
LCOE	Levelised Cost of Energy
LED	Light-emitting Diode
LEED	Leadership in Energy and Environmental Design
LEME	List of Eligible Equipment and Materials
LGA	Local Government Area
LHP	Large Hydropower
LNG	Liquefied Natural Gas
LOI	Letter of Intent
LV	Low Voltage
MAN	Manufacturers Association of Nigeria
MEPS	Minimum Energy Performance Standard
MFI	Main Financial Institution
MIGA	Multilateral Investment Guarantee Agency
MO	Market Operator
MRC	Mortgage Re-financing Company
MSME	Micro, Small- and Medium-Scale Enterprises
MSW	Municipal Solid Waste
Mtoe	Million Tonnes of Oil Equivalent
MYTO	Multi Year Tariff Order
NACAN	National Advocacy Campaign on Adaptation in Nigeria

NACCIMA	National Association of Chambers of Commerce, Industry, Mines and Agriculture
NAE	Nigeria Alternative Energy
NAPTIN	National Power Training Institute of Nigeria
NARAP	Nigerian Association of Refrigeration and Air Conditioning Practitioners
NASENI	National Agency for Science and Engineering Infrastructure
NASPA-CCN	National Adaptation Strategy and Plan of Action for Climate Change in Nigeria
NBET	Nigerian Bulk Electricity Trading Plc
NBS	National Bureau of Statistics
NCCS	National Clean Cooking Scheme
NCEAP	Nigerian Clean Energy Access Program
NCEEC	National Centre for Energy Efficiency and Conservation
NCERD	National Centre for Energy Research and Development
NCHRD	National Centre for Hydropower Research and Development
NCPRD	National Centre for Petroleum Research and Development
NCS	Nigerian Custom Service
NDPHC	Niger Delta Power Holding Company
NEEDS	National Environmental, Economic and Development Strategy
NEEP	National Energy Efficiency Policy
NEMP	National Energy Master Plan
NEP	National Energy Policy
NEPA	National Electric Power Authority
NEPP	National Electric Power Policy
NERC	Nigerian Electricity Regulatory Commission
NESI	Nigeria Electricity Supply Industry
NESP	Nigerian Energy Support Programme
NESREA	National Environmental Standard and Regulatory Agency
NGC	Nigerian Gas Company Limited
NGF	Nigeria Governors" Forum
NGEP	Nigerian German Energy Partnership
NGN	Nigerian Naira (Currency)
NIA	Nigerian Institute of Architects
NIAF	Nigeria Infrastructure Advisory Facility
NIOB	Nigerian Institute of Building
NIPC	Nigerian Investment Promotion Commission
NIPP	National Integrated Power Project
NIS	Nigerian Industrial Standard
NIYAMCO	Nigerian Yeast and Alcoholic Manufacturers
NNPC	Nigerian National Petroleum Corporation
NOO	National Ozone Office
NORAD	Norwegian Agency for Development Cooperation
NPC	National Planning Commission
NREEEP	National Renewable Energy and Energy Efficiency Policy
NSE	Nigerian Society for Engineers
NUMCO	Nigerian Uranium Mining Company
ONEM	Operator of the Nigerian Electricity Market
OPEC	Organisation of the Petroleum Exporting Countries
OPIAMU	Ozone Project Implementing and Management Unit
PACP	Presidential Action Committee on Power
PCHN	Power Holding Company of Nigeria
PDP	People's Democratic Party
PHCN	Power Holding Company of Nigeria
PIB	Petroleum Industry Bill
PMS	Premium Motor Spirit
PPA	Power Purchasing Agreement
PPP	Public Private Partnership

PSF	Petroleum Support Fund
PTFP	Presidential Task Force on Power
PV	Photovoltaic
PVES	Photovoltaic Energy Systems
QIPP	Qua Iboe IPP
RE	Renewable Energy
REA	Rural Electrification Agency
REAP	Renewable Electricity Action Programme
REEEP	Renewable Energy and Energy Efficiency Programme
REF	Rural Electrification Fund
REMP	Renewable Energy Master Plan
REP	Rural Electrification Policy
REPG	Renewable Electricity Policy Guidelines
REPP	Rural Electrification Policy Paper
REPS	Renewable Energy Power Systems
RESP	Rural Electrification Strategy and Plan
RESP	Rural Electrification Strategy and Plan
RET	Renewable energy technologies
RUWES	Rural Women Energy Security
SCADA	Substation Control and Data Acquisition
SERC	Sokoto Energy Research Centre
SHP	Small Hydro Power
SHS	Solar Home Systems
SME	Small- and Medium-Scale Enterprises
SO	System Operator
SON	Standards Organisation of Nigeria
SONCAP	SON Conformity Assessment Programme for Exports
SURE-P	Subsidy Reinvestment and Empowerment Programme
SWH	Solar Water Heaters
TCN	Transmission Company of Nigeria
TEM	Transitional electricity market
TIB	The Infrastructure Bank, Nigeria
TPES	Total Primary Energy Supply
TSP	Transmission Service Provider
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-HABITAT	United Nations Human Settlement Programme
UNHCR	United Nations High Commissioner for Refugees
UNICAL	University of Calabar
UNIDO	United Nations International Development Organisation
UNOPS	United Nations Office for Project Services
US$	United States Dollar (Currency)
USA	United States of America
USAID	United States Agency for International Development
WB	World Bank
WEM	Wholesale Electricity Market
WIS	Wind Information System

Units of Measurement

Unit	Description
Btu	British thermal units
GW	Gigawatt
GWh	Gigawatt hours
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt hours
ML	Million Litres
MW	Megawatt
toe	Tons of oil equivalent

Exchange Rates

1 Euro (EUR) equals 200 Naira (NGN)
1 US Dollar (US$) equals 160 Naira (NGN)

1. EXECUTIVE SUMMARY

The Nigerian energy sector has changed fundamentally in recent years. The Nigerian Government has made it clear that it seeks to deregulate and restructure the sector, with the goal to completely unbundle the oil and gas sector and to privatise the power sector. An indication of this approach was the withdrawal of a large percentage of the subsidy on petrol in January 2012, following the deregulation of the diesel market in summer 2009, in an effort to free up revenue for infrastructure investments.

With an installed capacity of 13 308 MW, only 6 158 MW were operational in 2014. Of these, only between 3000 MW to 4 500 MW are actually being generated due to unavailability of gas, breakdowns, water shortage and grid constraints. The poor performance of the power plants has led to acute shortage of power across the country.

Altogether, up to 2 700 MW of power generation capabilities are regularly lost due to gas constraints in a country with one of the largest natural gas deposit in the world. Up to 500 MW are lost due to water management, while several hundred megawatts are regularly lost due to line constraints. Industry, commerce and private households are suffering from a severe shortfall in electricity generation.

With the intention of incentivising private-sector investment in the power sector, the government has privatised the generation and distribution sections in two waves. The proceeds are sensibly being dedicated to infrastructure expansion and, in the case of the second wave, a large part of the revenue has been earmarked for expansion of the country's array of hydropower plants.

However, the process of privatisation is still ongoing. At present it is impossible to say with any certainty whether the independent power producers who now form the backbone of the Nigerian power sector will be commercially viable. As part of the process, however, the government has started to encourage investments in both renewable energy and energy efficiency.

This study is elaborated under the framework of the Nigerian Energy Support Programme (NESP), financed by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the European Union and administered by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), in cooperation with the Federal Ministry of Power and other Nigerian partner organisations.

The Study Purpose

The study seeks to outline the current status of the Nigerian energy sector and to analyse which opportunities this spells for the subsectors of on-grid renewable energy, energy efficiency and off-grid rural electrification.

This study provides national stakeholders, international development partners and private investors with an overview and supplementary baseline information in order to initiate and facilitate the flow of private and public investments into the fields of renewable energy and energy efficiency. The study is based on data gathered from existing databases and a series of interviews conducted in the country from January until October 2014 and feedback received by April 2015.

Any such study is beset by the challenge of identifying reliable data. In the absence of a central electronic data gathering unit in the power sector and conflicting statements made in the context of political agenda setting, data verification by comparison with at least one other data set has been difficult.

Moreover, sources are not always given in studies or papers that offer statistics, meaning citation of such sources is potentially problematic, especially if they are the only source. For the purposes of this study we have consulted national and international data sets for each case.

Structure of the Study

Chapter 2 (Introduction to Nigeria) and Chapter 3 (The Nigerian Energy Sector) give an introduction to the Nige-

rian context, the economy and current status of the energy sector. The latter chapter further deliberates on the current status of ongoing privatisation in the energy sector. Chapter 4 (Energy Market – Stakeholders and Roles) explains the energy market, its stakeholders and their main roles and functions.

Policies and strategies in the fuel and electricity market are outlined in Chapter 5 (Energy Policy). This chapter gives a fundamental overview of the laws, regulations, policies and programmes currently enacted or under discussion.

Chapter 6 (On-Grid Renewable Energy) identifies the immense potential for private investment in renewables today and highlights the role this could play in significantly boosting the national generation capacity. As regards energy efficiency, in Chapter 7 (Energy Efficiency) the study identifies high potential for energy efficiency gains.

In Chapter 8 (Rural Electrification, Including Off-Grid Renewable Energy), the study explores the status of rural electrification in Nigeria today and the policies put in place to increase access to energy. Conclusions and recommendations and are presented in Chapter 9, Concluding Remarks.

Main study findings and recommendations

On-Grid Renewable Energy

The reasoning for on-grid renewables is strong. On the one hand, power plants overcome geographical grid challenges and on the other hand, renewable energies offer fast-delivery solutions and are cost-effective especially when replacing diesel generation capacity. At the same time, challenges are highlighted in what could be a key pioneering area.

The study's main recommendations are:

1. to set-up a structured and reliable support mechanism such as a Bidding System for utility scale (larger than 10 megawatt) renewable energy and a feed-in tariff for small renewable energy projects
2. to focus efforts on development of solar photovoltaic (PV) farms and small hydropower plants (primary focus on quick wins)
3. to link the vast biomass potential to rural electrification schemes
4. to pin-point the wind potential through detailed mapping and the identification of development corridors
5. to align policies between governmental institutions, thus mitigating potential conflicts and to continue the support of the nation's current electricity delivery system
6. to strengthen key stakeholders capacity in order to ensure the achievement of the policy targets and to monitor and evaluate its results based on sound data and reliable statistical records
7. to develop financial and investment instruments including public-private partnerships (PPPs) and promote the contribution of private banks and International Financial Institutions (IFIs)

Energy Efficiency

The energy efficiency market is a start-up market. As part of the process, the government has started to draft mechanisms to encourage investments in energy efficiency through policies, strategies and support provisions. Up to now there is neither real experience, nor historical data available. At the same time, it is now well understood that energy efficiency is a source of energy.

The study's main recommendations are:

1. to familiarise institutions with the concepts of energy efficiency and energy management, and to build capacities for policy development, implementation and monitoring
2. to finalise, approve and operationalise the National Energy Efficiency Policy (NEEP) including the mix of regulatory policy and public financing mechanisms in order to give a clear basis for decision making to investors
3. to develop financial and investment instruments

adapted to each energy efficiency market segment (for example for industry/buildings: to offer incentives through savings from a better conversion rate and for the private household segment: microfinance schemes; non-bank financial institutions; bank consumer loans for appliances; leasing provisions; donor lending programmes)

4. to create a greater government and public awareness in two areas: the use of efficient diesel generators and in the introduction of standards and labels
5. for industry to focus primarily on the establishment of an energy efficiency financing facility designed for small- and medium-sized enterprises (SMEs)
6. for buildings (with a primary focus on public buildings) to develop and implement energy building codes
7. for household appliances to introduce energy efficiency standards as a first priority

Off-Grid Rural Electrification

The study determines that there is great potential for rural electrification and that some of it could be accounted from renewable sources. However, the government will need to address the issue of sourcing of investments. Potentially, this third subsector is the one where government and international donor agencies will need to join forces.

The study's main recommendations are:

1. to finalise, approve and operationalise the Rural Electrification Strategy and Plan (RESP) incl. the mix of regulatory policy and public financing mechanisms
2. to operationalise the Rural Electrification Fund (REF) and IFIs a clear basis for decision making
3. to strengthen institutions to ensure the delivery of the RESP targets including its monitoring and evaluation based on sound data and relevant statistical records
4. for solar PV, to encourage the provision of solar packs (incl. panels and battery storage systems backed up by O&M instructions) for households and microsystem water irrigation pumps
5. for micro-hydro schemes to first evaluate the cost/benefits of run-of-the-river micro systems and of converting micro-dams into hydropower systems
6. for wind, to encourage stand-alone microsystem water irrigation pumps (backed up by instructions schemes on O&M)
7. for biomass, to first assess the prospects of small bio-digesters in line with the biomass resource potential

2. INTRODUCTION TO NIGERIA

The Federal Republic of Nigeria is a federal constitutional republic comprising thirty-six states and the Federal Capital Territory, Abuja. The country is located in West Africa and shares land borders with the Republic of Benin in the west, Chad and Cameroon in the east, and Niger in the north. Its Atlantic coast runs along the Gulf of Guinea, in the south.

The following chapters will summarise key aspects around the geography, climate, political situation, demography, economy and Nigeria's regional context.

2.1 Geography, Climate and Political Situation

2.1.1 Geography

Since 1991, the capital city is Abuja. At its widest, Nigeria measures about 1,200 km from east to west and about 1,050 km from north to south. The country's topography ranges from lowlands along the coast and in the lower Niger Valley to high plateaus in the north and mountains along the eastern border. The country is bifurcated by two main rivers, the Niger and the Benue. The ecology

FIGURE 2 – 1:
MAP OF NIGERIA

(Prepared by GOPA-International Energy Consultants GmbH)

varies from tropical forest in the south through savannah to the sub-Sahel zone in the far north. Figure 2 – 1 shows the map of Nigeria.

TABLE 2 – 1: NIGERIA´S GEOPOLITICAL ZONES WITH CORRESPONDING STATES AND LAND MASS

Geopolitical Zones	States	Land Area in km²
North-Central	Abuja-FCT	7,607
	Benue	30,800
	Kogi	27,747
	Kwara	35,705
	Nasarawa	28,735
	Niger	76,469
	Plateau	27,147
North-East	Adamawa	38,700
	Bauchi	49,119
	Borno	72,609
	Gombe	17,100
	Taraba	56,282
	Yobe	46,609
North-West	Kaduna	42,481
	Kano	20,280
	Katsina	23,561
	Kebbi	36,985
	Jigawa	23,287
	Sokoto	27,825
	Zamfara	37,931
South-East	Abia	4,900
	Anambra	4,865
	Ebonyi	6,400
	Enugu	7,534
	Imo	5,288
South-South	Akwa-Ibom	6,900
	Bayelsa	9,059
	Cross-River	21,787
	Edo	19,187
	Delta	17,108
	Rivers	10,575
South-West	Ekiti	5,435
	Lagos	3,671
	Ogun	16,400
	Ondo	15,820
	Osun	9,026
	Oyo	26,500
TOTAL km²		**917,434**

(Prepared by GOPA-International Energy Consultants GmbH)

The Federal Republic of Nigeria is divided into six geopolitical zones and 36 federal states. Table 2 – 1 and Figure 2 – 2 show the federal states and the Federal Capital Territory, Abuja.

2.1.2 Climate

Temperatures across the country are relatively high, with very narrow variation in seasonal and diurnal ranges, and wide regional differences. There are two main seasons: the rainy season (usually April to October); and the dry season (November till March). The dry season commences with Harmattan winds, a dry chilly spell that lasts till February and is associated with lower temperatures and dust brought by the winds blowing from the Arabian Peninsula across the Sahara. The second half of the dry season, namely February till March, is the hottest period of the year (temperatures range from 33 to 38 °C and are at their highest, as is aridity, in the north). Given this climatological cycle and the size of the country, there is a considerable variation in total annual rainfall across the country, both from south to north and, in some regions, from east to west. The maximum total precipitation is generally in the southeast, along the coastal area of Bonny and east of Calabar, where mean annual rainfall is more than 4,000 millimetres. A table of annual rainfall by state is included in Annex 1, Table A – 1.

Köppen-Geiger classified the world into climate zones. A world map of climate zones has been updated by [Peel, M. C., Finlayson, B. L., and McMahon, T. A; 2007]. According to this world map, Nigeria has five climatic zones ranging from tropical rainforest climate in the south to dry desert climate in the north (cf. Annex 1, Figure A – 1). Examples of climate charts for different locations across Nigeria, namely for Kano, Minna and Lagos are shown in Annex 1, Figure A – 2, Figure A – 3 and Figure A – 4.

2.1.3 Political Situation

After decades characterised by intermittent civilian rule and military leadership, Nigeria has been ruled democratically since 1999. The political system is a presidential democracy with parliamentary responsibility distributed

across a bicameral system of a senate and a house of representatives.

The party system has gone through a transformation process where the People's Democratic Party (PDP) has relinquished much political power and faces a strong opposition. In February 2013, the All Progressives Congress (APC) arose as the result of a merger by Nigeria's four biggest opposition parties.

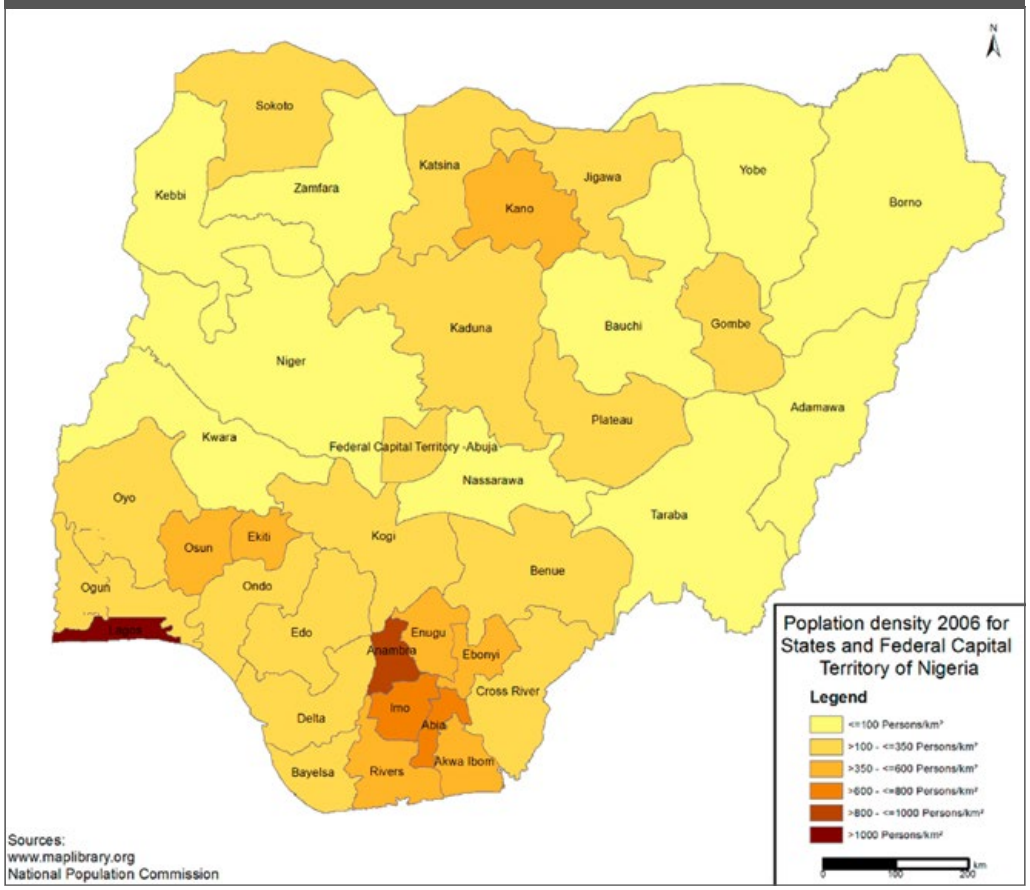
In April 2015, former military ruler Muhammadu Buhari (APC) has become the first opposition candidate to win a presidential election in Nigeria. He already ruled Nigeria from January 1984 until August 1985 after staging a military coup. His predecessor, Goodluck Jonathan (PDP), led Nigeria since 2010.

Nigeria has suffered from several attacks by the Islamist militant group Boko Haram, which is especially active in the North Eastern geopolitical zone. The group has killed thousands of people in its strive to establish an Islamic state.

2.2 Demography

With a population of over 170 million, Nigeria is the most populous country in Africa and the eighth most populous country in the world. According to the United Nations, one in six Africans is Nigerian. It is a regional power, listed among the "Next Eleven" economies, and a member of the Commonwealth of Nations. The current population density varies among the Nigerian states. States in the north east and north west tend to be less populated (cf. Figure 2 – 2). There is only one state with

FIGURE 2 – 2:
POPULATION DENSITY IN NIGERIA IN 2006



(Prepared by GOPA-International Energy Consultants GmbH)

more than 1,000 inhabitants per square kilometre, namely the megacity of Lagos with a population rate of 2,695 persons/km² and a total population of 9,113,605 in 2006 [NBS; 2011] (cf. Figure 2 – 2). [25], [60] Approximately half of the inhabitants live in urban areas.

The population growth rate is projected to be between 2.5 and 2.7% per annum in the next 20 years. The population of Nigeria is therefore forecast to potentially grow to 310 million by 2035 (cf. Annex 1, Table A – 2). A total of 54.4% of the population were living below the international poverty line of US$ 1.25 per day in 2011 according to the World Bank [25], [60]. Moreover, 46% of the population live below the national poverty line [1]. A middle class has been fast emerging in recent years, especially in the cities.

2.3 Economy

Nigeria's Gross Domestic Product (GDP) was revised in 2013. GDP is typically measured by reference to the shape of the economy in a "base" year. Statisticians sample businesses in different industries to see how fast they are growing. The weight they give to each sector depends on its importance to the economy in the base year. Naturally, these figures become less and less accurate over time. Nigeria's old GDP data relied on an outdated snapshot of its economy in 1990. The new figures (which have 2010 as the base year) give due weight to fast-growing industries such as mobile telecoms and film-making that have sprung up since then. Moreover, Nigeria's statisticians have improved the gathering of data. For instance, the old GDP figures were based solely on estimates of output. The new ones are now being reconciled with separate surveys of spending and income.

As a consequence of the re-basing, the estimate for Nigeria's GDP in 2013 was revised upward from 42.4 trillion Naira to 80.2 trillion Naira ($500 billion), an 89% increase (cf. Table 2 – 2). With the re-based GDP, Nigeria overtook South Africa and is now the largest economy on the continent.

TABLE 2 – 2:
NIGERIA MACROECONOMIC INDICATORS BEFORE[1] AND AFTER RE-BASING[2]

Year	1980*	1985	1995	2005	2010	2011	2012	2013	2014[3]	2015[3]	2016[3]
GDP, current prices, US$ billion	60.6	26.0	36.9	112.2	369.1	414.1	461.0	515.0	581.9	597.8	661.4
GDP nominal growth, (%)	–	-57.1	17.4	142.0	15.32	13.87	11.68				
Real GDP growth (%)					7.8	4.9	4.3	5.4	6.2	5.6	6.5
GDP per capita, current prices, US$**	885	331	356	824	2,396	2,612	2,835	3,082	3,416	3,677	

1 Source: [IMF; Oct 2013]
2 Source: [EIU; 2014]
3 EIU estimation and forecast
* 1980 - 2005 figures: before rebasing (italics); figures for 2010 onwards after rebasing
** from 2010 onwards AfDB data [80]

1 National estimates are based on population-weighted subgroup estimates from household surveys. World Bank data are based on World

The nominal GDP growth rate was 11.68 % in 2012 and according to the Economist Intelligence Unit [EIU; 2014] real GDP is expected to further grow at a constant rate of around 7% per year. Based on old data (i.e. before rebasing) it could be concluded that the non-oil sector drove the economy, with average growth of about 10% in 2012, compared to –0.35% for the oil and gas sector [IMF; Oct 2013]. High consumer demand was the main force behind non-oil sector growth.

The inflation rate averaged 12% over the last 20 years and stood at 8.1% in 2014.

The Nigerian economy still suffers from inadequate diversification in the wake of first commercial oil production in the late 1950's and the collapse of the nascent manufacturing sector from the mid-1980's onwards. For example, since that time car assembly in Nigeria has ceased and the tire industry has collapsed. The sporadic availability of electricity still forces manufacturers to deploy diesel generators for reliable electricity supply. In consequence this induces uncompetitive electricity cost and frequently leads to factory closings (further details in Chapter 3).

TABLE 2–3:
SECTORAL SHARES OF GDP IN PERCENT, 2012

%	New	Old
Agriculture	22.1	33.1
Crude Oil and Gas	15.8	37
Trade	16.5	15.5
Manufacturing	7.4	1.9
Of which food and tobacco	4.4	–
Construction	3.1	1.3
Transportation	1.3	1.6
Telecommunications	8.3	0.8
Electricity and Gas	0.5	0.2
Finance and Insurance	2.8	1.6
Real Estate	7.7	4.5
Entertainment, Broadcasting, Motion Pictures, Music	2.0	–
Public Administration	3.1	–
Prof., Scientific and tech. services	3.7	–
Other	5.7	2.5

Source: [NBS 2014]

The top five drivers of the economy are the following sectors: agriculture, trade, oil and gas, information and communications, and manufacturing. These top five sectors represent more than 70% of total GDP [NBS; 2014]. The main businesses are cement production, light industry (aluminium processing, paints), food and beverage packaging, as well as subsectors supplying the oil and gas industry. The latter are increasingly indigenous operations.

The country has about 70 million hectares of farmland, primarily located in the Middle Belt, with areas in the sub-Sahel zone largely untouched to date owing to a lack of irrigation capacity. Despite this agricultural potential, less than 50% of the total farmland in Nigeria is cultivated, and agricultural productivity is low because of the lack of modernisation. Nigeria today imports food to meet domestic demand, with the import bill for wheat, rice, sugar and fish estimated at NGN 1 trillion (US$ 6.4 billion) per annum. Agriculture sources some 20% of GDP and employs about 70% of the work force. [1]

These main drivers of economic growth do not require large amounts of labour and thus fail to absorb the 1.8 million new annual entrants into the labour market. The unemployment rate according to the definition of the International Labour Organisation (ILO) is below 10%, while a stricter definition applied by the Nigerian government sets this figure at 24% for 2011.

2.4 Regional Context

Nigeria is West Africa's powerhouse in terms of population and GDP. It represents 55% of West Africa's GDP, whereby for instance the GDP of Lagos is larger than that of Ghana. Nigeria's rebased GDP (cf. Chapter 2.3) makes Nigeria the largest economy in Africa and the 26th largest economy in the world.

Nigeria is a driving force on the continent through its strategic and financial leadership in the Economic Community of West African States (ECOWAS). Abuja has been home to the ECOWAS headquarters since the organisation was founded in 1975. Conversely, Nigeria's internal problems dog the sub-region, and commentators have suggested this has led to the stalling of the political and economic integration of ECOWAS. At the same time, Nigeria provided the African Union contingent in Mali and is driving economic growth in the region, with Nigerian companies investing in many other West African countries.

Nigeria is also part of the West African Power Pool (WAPP), a specialized institution of ECOWAS. The target of WAPP is to ensure regional power system integration and realization of a regional electricity market. It covers public and private generation, transmission and distribution companies.

The power sector in Nigeria is seen by many analysts as the key constraint on economic development. Assessing the ease of getting electricity, the World Bank ranked Nigeria 187 of 189 countries in the 2015 edition of its Doing Business report. For a business in Lagos, to obtain permanent electricity connection takes 260 days [WB; 2014: b]. Once connected to the electricity provider, Nigerian businesses' biggest reported problem is the erratic power supply. About 83% of all managers surveyed considered electricity outages to be a serious problem – more than any other constraint. Firms of all sizes, in all states and sectors, report average power outages equivalent to eight hours per day. The average firm claims outage related losses equivalent to more than 4% of sales. No peer country experiences such severe business losses related to the power supply. [World Bank (WB); 2011]

The underlying reasons for the negative development regarding electricity supply in Nigeria are apparent. Investment in the nationalised power sector had seriously diminished by the early 1990's, with maintenance budgets greatly reduced and no new capacity added. This statement applies to both the national grid and the fleet of power stations. The gap between the latter's nameplate capacity and actual generation capacity widened constantly by the end of the 20th century and is still the main barrier to stable and reliable energy supplies to the Nigerian consumers.

Alarmed by the critical electricity supply situation the government privatized the electricity sector in 2013 with the aim to improve the reliability of electricity supply (cf. Chapter 3.4) [75]. However, the restructuring of the sector will inevitably take its time and will only gradually alter the reliability of the system.

In addition to the challenges caused by its weak electricity sector, Nigeria also faces challenges in its historically strong oil industry.

Nigeria is Africa's largest oil producer and in 2012 was the world's fourth largest exporter of liquefied natural gas (LNG from associated petroleum gas). Against this backdrop it is no surprise that mining and quarrying (incl. crude oil) is one of the top 5 drivers of the Nigerian economy. While oil only contributes 16% the GDP, it accounts for approx. 75% of Government revenues and 90% of export earnings.

However, Nigeria's oil production is at present impeded by the challenges of oil theft and supply disruptions caused by pipelines being sabotaged or failing. The gas sector is restricted by the ongoing shortfall in infrastructure to monetise gas that is presently flared [2]. And even though Nigeria is among the leading exporters of crude oil in the world, it still imports about 85% of its refined petroleum products due to low capacity utilisation of its domestic oil refineries (around 30%). While the price of petrol at the pump is still subsidised in order to compensate for the high prices of international traded refined oil,[3] the diesel price was deregulated in 2009. This significantly increased the cost of private electricity generation.

Due to the high dependence of the Nigerian economy on its oil industry, changes in oil prices in the international market naturally have a big impact on Nigeria's overall revenue. Accordingly, the sharp fall in oil prices between July 2014 and January 2015 has resulted in a 28 % drop of Nigeria's revenue. [76]

3.1 Energy Resources

According to the Organisation of the Petroleum Exporting Countries (OPEC), Nigeria, Africa's largest oil producer has about 37 billion barrels of proven oil reserves and 187 trillion cubic feet of proven natural gas reserves. With an average production of approx. 1.8 to 2.4 million barrels of oil per day, Nigeria is ranked seventh largest OPEC crude oil producer between 2009 and 2013 [47]. To date, there has been no dedicated gas exploration, and

[2] Efforts are being made to promote foreign direct investment in the domestic gas infrastructure. One project of note is the planned Delta Gas City in Ogidigben, Warri-South Local Council Area of Delta State. [17], [64]

[3] Petrol subsidies amounted to almost 1 trillion Naira (6.25 billion US$) in 2014, but are likely to be reduced substantially in 2015 due to decrease of oil revenues.

the gas reserves consist solely of associated petroleum gas. While the natural gas reserves remain untapped, Nigeria exported more than 8% of globally traded liquefied natural gas (LNG from associated petroleum gas) in 2012 (4th largest producer worldwide) [63]. Moreover, there are strong coal seams in Kogi and Enugu states that have not yet been mined on a large scale, although plans are already afoot.

Proven reserves of oil and gas are listed in Table 3 – 1. With the current production of fuel, 42 years of extraction of oil and 120 years of extraction of gas remain.

To date, Nigeria has tended to rely on its fossil fuel resources. At the same time, the country since the late 1960's has focused on establishing hydropower plants in order to exploit the great potential available (cf. Chapter 3 – The Nigerian Energy Sector). The country's strong potentials for renewable energy are further described in Chapter 6 – On-Grid Renewable Energy.

3.2 Primary Energy Supply

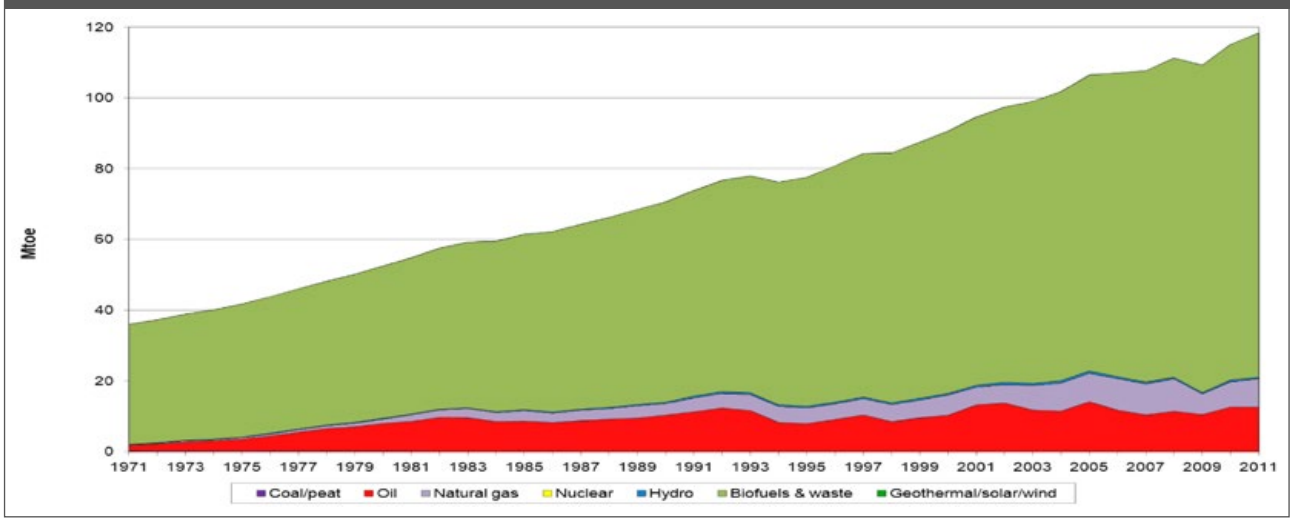
The historic development of energy supply in Nigeria is illustrated in Figure 3 – 1. Since the 1970's the reliance on biofuels and waste has risen in absolute terms, while that of oil and natural gas has remained fairly constant, despite the increase in the extractive industries. Presumably this can be attributed to the cost of oil and natural gas to the consumer, the lack of domestic refining, and the absence of a pronounced infrastructure for domestic gas utilisation. Chapter 8 will further deal with Nigeria's high dependence on biofuels and waste.

TABLE 3 – 1:
OVERVIEW OF FOSSIL FUEL RESOURCES, 2012

	Oil	Gas	Coal (total recoverable)
Reserves	37.2 billion barrels	5.2 trillion cubic metres	209.4 (million short tons) (2008)
Production	2417 thousand barrels per day	43.2 billion cubic metres per year	n/a
Years of extraction remaining	42 years	120 years	n/a

Source: [BP; 2013]

FIGURE 3 – 1:
HISTORICAL TOTAL PRIMARY ENERGY SUPPLY (MTOE) 1971-2011



Source: IEA, [46]

Table 3 – 2 summarizes the energy balances for Nigeria in 2012, based on the statistics from the International Energy Agency [46]. According to this data, in 2012 total Nigerian primary energy supply was 133.7 Million tons of oil equivalent (Mtoe) excluding the electricity trade. The share of biofuels and waste was about 80.9%, while natural gas with 9.4%, oil with 5.7%, and hydropower with 0.4% show significantly smaller shares.

It bears noting that despite being a leading oil and liquid natural gas producer, Nigeria paradoxically imports the fossil-fuel products it currently uses. Accordingly a total of 8.44 Mtoe of oil products was imported. Exports comprise crude oil with 126.4 Mtoe, oil products with 0.8 Mtoe and natural gas with 21.0 Mtoe. This situation is mainly caused by the former mentioned shortage of domestic refining facilities.

TABLE 3 – 2:
ENERGY BALANCES FOR NIGERIA IN 2012 (KTOE)

Energy Balances for Nigeria in 2012 (ktoe)	Coal and peat	Crude oil	Oil products	Natural Gas	Hydro	Biofuels and waste	Total
Production	30	129,409	0	33,645	487	108,142	271,712
Imports	0	0	8,440	0	0	0	8440
Exports	0	-126,413	-755	-21,032	0	0	-148,201
International marine bunkers	0	0	-397	0	0	0	-397
International aviation bunkers	0	0	-186	0	0	0	-186
Stock changes	0	1830	538	0	0	0	2368
TPES[1] Total Primary Energy Supply	**30**	**4,825**	**7,640**	**12,613**	**487**	**108,142**	**133,736**
TPES (%)	**0.02%**	**3.61%**	**5.71%**	**9.43%**	**0.36%**	**80.86%**	**100.00%**

Source: IEA, [46]

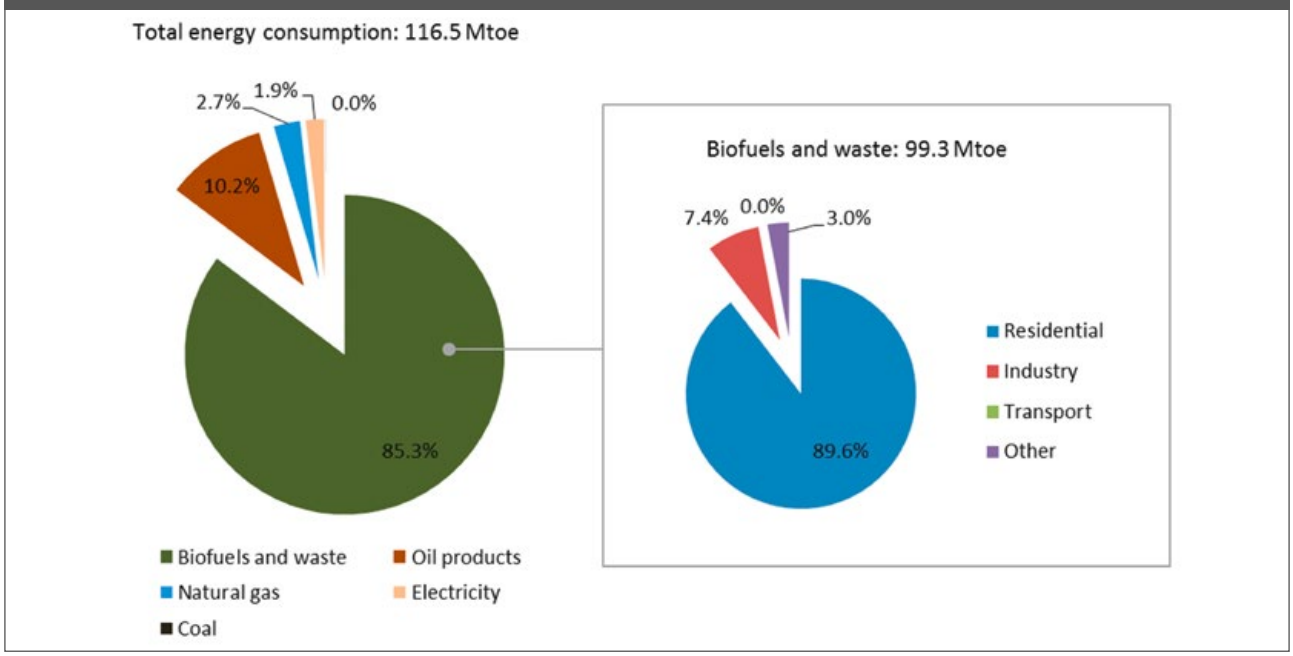
[1] Totals may not add up due to rounding

3.3 Energy Consumption

Figure 3 – 2 shows the total energy consumption by resources for Nigeria in 2012 [46]. Around 85% of Nigeria's consumed energy, 99.3 Mtoe annually, comes from biofuels and waste. Almost 90% of that energy is consumed for residential usage. This means that biofuels and waste covers about 98% of the energy demand in the residential sector. The lion's share of that most probably is for cooking purposes, as only thus can the predominant proportion of biofuels and waste be explained. The remaining energy in Figure 3 – 2 stems from conventional energy resources (~13%), with most of it being reimported oil products. The share of electricity in final energy consumption is almost marginal at less than 2%.

The use of biofuels is the single largest factor accounting for the change in the country's vegetation and the increase in desertification [4]. Moreover, the problem will be compounded as the rural population increases in line with the forecast rate of 2.5% p.a.

FIGURE 3 – 2:
TOTAL ENERGY CONSUMPTION BY RESOURCES IN 2012



Source: IEA, [46]

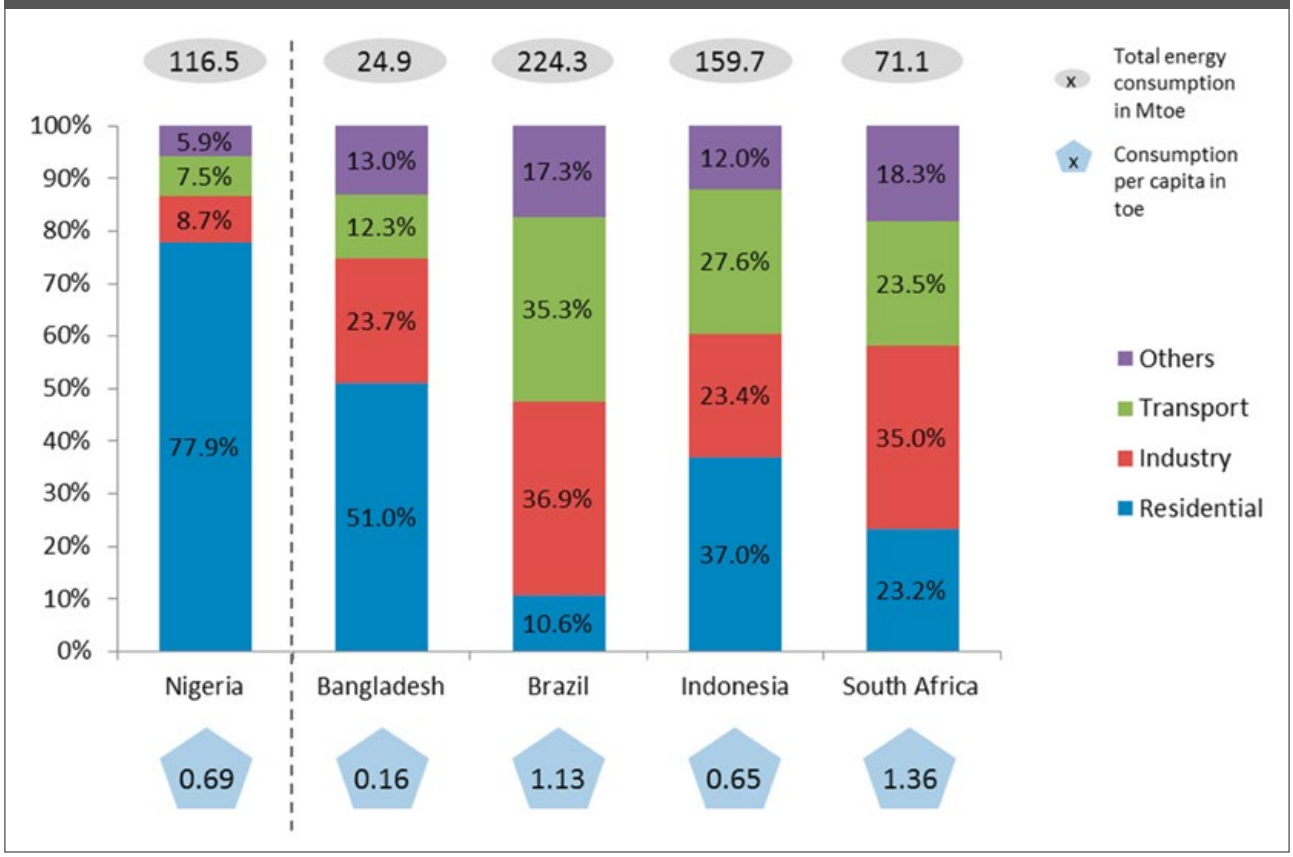
Excursus: Annual fuel wood consumption per person:

Given a population of 170 million, primary energy consumption translates into 6,650 kWh per person. With a cubic metre of wood sourcing 2,600 kWh, per capita consumption of fuel wood is 2.5 m³. Given, moreover, that about 69.8% of Nigerian population depends on fuel wood for domestic and cottage industry purposes, those using fuel wood for energy purposes are consuming about 3.3 m³ of wood a year. The situation is compounded by the predominant use of inefficient cooking methods, based largely on open fire with obviously low thermal efficiency and associated smoke related ailments, especially among women and children.

4 The Approved National Forest Policy of 2006 states that between 1978 and 1995, there was a decrease in natural forests from 23,429,100 ha. to 15,097,900 ha. (25.7% to 16.0%), with a decrease in shrub/grassland from 13,441,200 ha. to 11,774,300 ha. (14.8% to 12.9%), while the increase in agricultural land use was from 50,293,500 ha. to 58,497,700 ha. (55.3% to 64.4%)

Figure 3 – 3 illustrates the total energy consumption by economic sectors as well as the consumption per capita for Nigeria and 4 other countries (Bangladesh, Brazil, Indonesia and South Africa), which for the remainder of this study will serve as a peer group.

FIGURE 3 – 3: TOTAL ENERGY CONSUMPTION BY ECONOMIC SECTORS AND CONSUMPTION PER CAPITA FOR NIGERIA AND PEER COUNTRIES (2012)



Source: IEA, [46]

With a share of about 78%, the residential sector accounts for most of the final energy consumption in Nigeria, followed by industrial use, whereby the latter only amounts to approx. 9%, followed by the rapidly expanding transport sector.

The peer-group comparison reveals that in percentage terms energy consumption in Nigeria is skewed firmly towards the residential sector. All other countries show a much lower share of residential energy consumption. In addition a shortfall in transportation infrastructure can be deducted. The peer group comparison also highlights the problems the Nigerian industry faces, as residential energy consumption outstrips that for industry by a factor of almost nine. Given the substantial proportion of the population that lives in rural areas, electricity generation to drive industrialisation and rural electrification are both policy imperatives.

Figure 3 – 3 also lists the per capita consumption per country. Nigeria's per capita energy consumption of 0.69 toe is almost equal to the figure in Indonesia. South Africa (1.36 toe) and Brazil (1.13 toe) on the other hand have a

significantly higher per capita consumption, while Bangladesh (0.16 toe) shows the lowest per capita consumption of all peers.

Detailed figures comparing Nigeria with its peers are provided in Annex 2 (cf. Table A – 4). This comparison reveals that, unlike the peers, Nigeria has by far the lowest total electricity consumption.

3.4 Electricity Market Development

Prior to the enactment of the Electricity Power Sector Reform Act (EPSRA, 2005), the Federal Government of Nigeria (FGN) was responsible for policy formulation, regulation, operation, and investment in the Nigerian power sector. Regulation of the sector was conducted by the Federal Ministry of Power (FMP) with operations handled by the National Electric Power Authority (NEPA), a wholly state-owned entity responsible for power generation, transmission and distribution. From 1972 to 2005, NEPA controlled about 94% of the generation capacity and 100% of the transmission and distribution sector of the industry.

To address the twin issues of NEPA's poor operational and financial performance, the FGN amended the then prevailing laws (Electricity and NEPA Acts) in 1998 to remove NEPA's monopoly and encourage private sector participation. The National Electric Power Policy, 2001, specified the reform agenda, while EPSRA provided the legal basis for the unbundling of NEPA, the formation of successor companies and the privatisation of the latter. The EPSRA envisages a phased implementation of the power sector reforms to strategically guide the current market into a competitive market based on clear regulatory frameworks [75]. Therefore, the evolvement of the Nigerian Electricity Supply Industry (NESI) is designed along four consecutive stages: i) Pre-Transition Stage, ii) Transition Stage, iii) Medium-Term Stage and iv) Long-Term Stage [75].

The Pre-Transition Stage embodies the beginning of the end of the monopoly and kicks off the physical unbundling and privatisation of the NEPA. For this purpose the NEPA was restructured and transformed into the Power Holding Company of Nigeria (PHCN). From 2007 until September 2013 PHCN acted as the state-owned agency responsible for generating, transmitting and distributing electricity for the entire country. Meanwhile the FGN sought to sell-off much of the state-owned stake in the electricity services industry, only retaining the transmission grid as a public entity.

As a first step the government-owned generating companies (GENCOs) were put up for sale in two forms: The thermal power stations were to be sold outright and the hydropower stations were concessioned. Moreover, distribution was unbundled into 11 successor distribution companies (DISCOs) [5]. The privatisation was undertaken in form of a competitive bidding process and was completed in November 2013 with the handover of asset to the 6 private generation and 11 distribution companies. FGN retained control of the transmission and system operation under the Transmission Company of Nigeria (TCN), which has a system and a market operator division. The transmission lines and generators are interconnected in a common grid, with a single control centre at Oshogbo (cf. Chapter 4.3).

As a second step, the FGN founded a regulator (NERC) and a bulk trader (Nigerian Bulk Electricity Trading Plc, NBET), whereby the latter shall only exist until such a time as the electricity market is fully privatised, after which the power purchase agreements it has signed will be passed on to the DISCOs. It also established the Operator of the Nigerian Electricity Market (ONEM) within TCN which acts as wholesale market and settlement operator. It therefore manages the metering system among generation, transmission and distribution companies.

[5] Distribution companies: Abuja, Benin, Eko, Enugu, Ibadan, Ikeja, Jos, Kaduna, Kano, Port Harcourt, and Yola

As a third step, the FGN put all ten new National Integrated Power Project (NIPP) power stations up for sale (with a combined capacity of 5,455 MW they were owned by the Niger Delta Power Holding Co. (NDPHC) and scheduled for completion in 2014) [6]. FGN has assigned NGN 50 billion (US$ 312.5 million) to escrow accounts to cushion losses that the GENCOs may suffer (be it from power transmission or due to a shortfall in supplies) and has also obtained a partial risk guarantee from the World Bank to the same end. The Nigerian Bulk Electricity Trading Plc (NBET) manages buying the electricity from the GENCOs and selling it to the DISCOs in the interim. [African Development Fund; 2013]

The Pre-Transition phase was accompanied by interim rules with the objective "to establish a framework to govern trading arrangements during the interim period when power purchase agreements (PPAs) between the privatised generation companies and NBET and vesting contracts between NBET and the privatised PHCN successor distribution companies has not yet become effective" [74].

In order to proceed into the Transitional stage, criteria referred to as Conditions Precedent, which are defined in the Market Rules for Transitional and Medium Stages of the NESI [74], have to be satisfied. In January 2015 the NERC determined that "the level of completion of all Conditions Precedent is sufficient to justify the evolution of the NESI by the commencement of the Transitional Stage Electricity Market (TEM)". Consequently the TEM commenced with effect from 1st of February 2015.

The time line below shows the evolution of the electricity market until commencement of the Transitional Stage Electricity Market (TEM):

2001	adoption of the National Electric Power Policy
2005	enactment of the Electric Power Sector Reform Act (EPSRA)
2005 – 2007	establishment of the Nigerian Electricity Regulatory Commission (NERC); formation of the Power Holding Company of Nigeria (PHCN); unbundling of the PHCN into 18 independent companies
2008 – 2009	publication of the Multi Year Tariff Oder (MYTO); the Power Sector Reform Committee was formed
2010 – 2012	the Nigeria Vision 20:2020 was launched; the Presidential Action Committee on Power (PACP) and the Presidential Task Force on Power (PTFP) were established; the Roadmap for Power Sector Reform was released; the Bulk Trader was established
2012	MYTO II was approved and released
2013	full privatisation of the generation and distribution subsectors; the transmission subsector was retained by Government but its management is currently under concession
2015	MYTO 2.1 was approved and released. Petitions by various consumer groups, evoked by electricity price increases of up to 80%, led to amendment of MYTO 2.1 and a price drop of ~50%
1st of February 2015	commencement of TEM, after NERC declared all Conditions Precedent listed in the market rules as satisfied
May 2015	unbundling of TCN into an Independent System Operator (public) and a Transmission Service Provider (private) has begun

[6] Regarding the generation assets, a distinction is being made between the PHCN Successor Generation Companies (i.e. the existing gas and hydro power plants that were sold to 6 so called private GENCOs), the NIPP projects (gas-fired power plants that were built by the Government and that are currently being sold to private investors) and new Independent Power Producers (IPPs) that will in future build greenfield plants. For more details see Chapter 4.3.

The TEM is characterised by "contract based arrangements for electricity trading and the introduction of competition for entry into the Market" [74]. This means that all electrical trading arrangements are bound by contracts. Hence Power Purchase Agreements (PPA), Vesting Contracts and Gas Supply Agreements, executed during the privatisation process, are effective now [75]. In the TEM ONEM as the market operator sets the financing required for generation, transmission and distribution on the basis of the amended Multi-Year Tariff Order 2.1 (MYTO 2.1). MYTO 2.1 is meant to be a fully cost reflective tariff and is designed to ensure full cost recovery for investors as well as to enforce confidence for financing and investment in the sector. [NERC; March 2015]

In May 2015 the Nigerian Government has begun to unbundle TCN by creating a state-controlled Independent System Operator (which includes the functions of the previous system and market operator divisions) and an eventually privatized Transmission Service Provider.

The third stage of the evolvement of the NESI is the Medium Term Stage and envisages the "introduction of generation competition within the Wholesale Electricity Market and a centrally administered balancing mechanism for the Wholesale Electricity Market" [73]. This stage has not yet been forthcoming.

3.5 Electricity Generation

Within the Nigerian electrical power system four basic power generation options are to be differentiated. These power generation options include i) transmission based on-grid generation, ii) embedded generation, iii) off-grid generation and iv) captive generation. While licenses are needed to operate a generator according to options i) to iii), captive generation only requires a permit by the NERC. In the following, these 4 options are described in more detail. [Detail; 2012]

All existing regulations only affect generation of electricity exceeding 1 MW of installed capacity. Captive generation implies that electricity is entirely consumed by the generator itself (no PPA required), for instance households or companies running their own Diesel generators. Hence captive generation is technically off-grid, meaning that it is not evacuated to the national grid or a distribution grid. Power generation based on an off-grid generation license is obviously also off-grid generation, but additionally requires external off-takers, which typically are households within a remote village, public facilities (e.g. schools, health stations) and/or businesses. A distribution license may also be required for this kind of power generation. On the other hand power generated by means of embedded generation is evacuated through a distribution system of an external distribution company; hence embedded generators are usually connected to the distribution grid. Finally, on-grid generation licenses are necessary for all power plants which evacuate their power on the national transmission grid. [Detail; 2012]

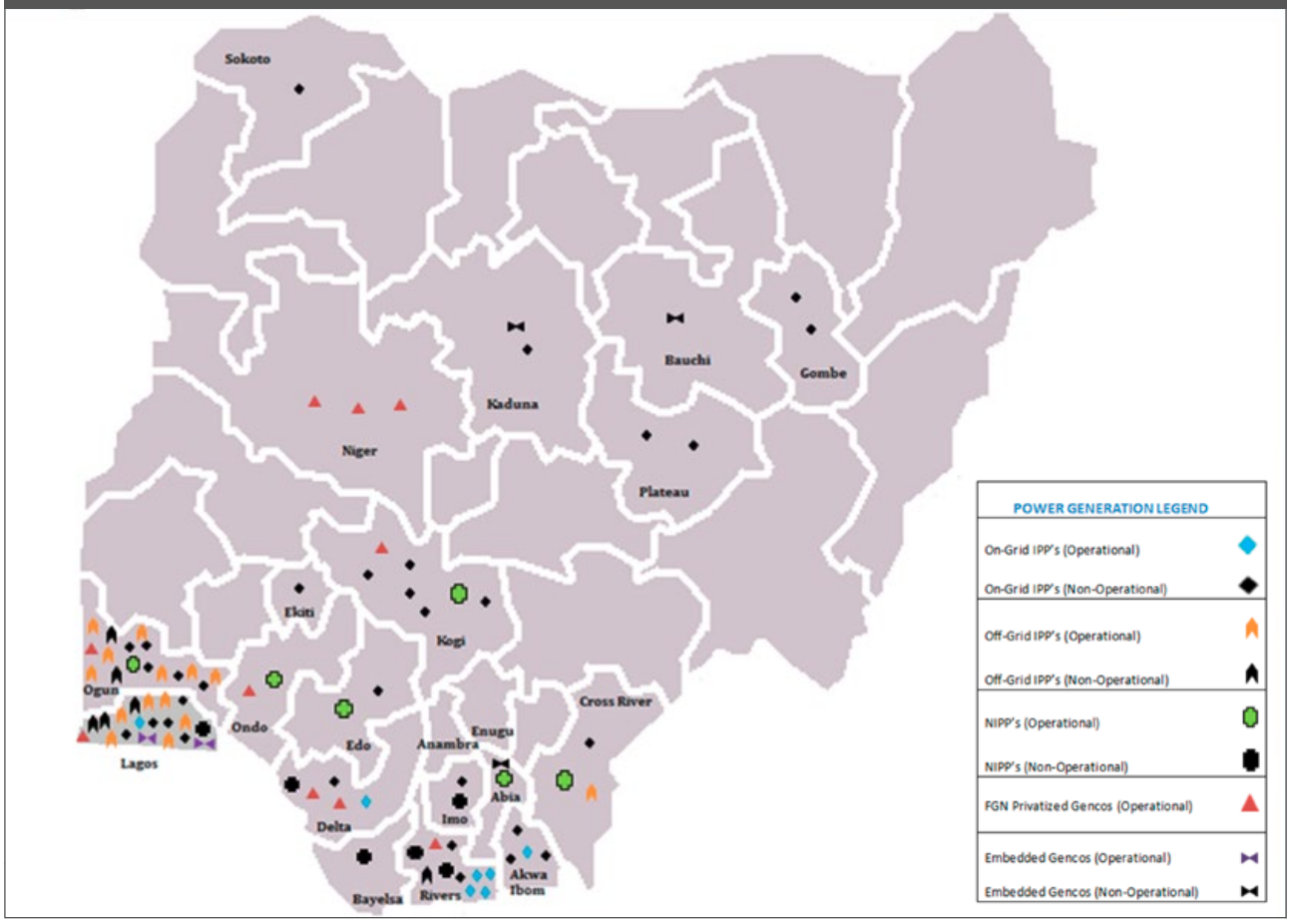
As a result, Nigerian's total power generation is a mixture of the power generation options described above. NERC only provides statistics on power plants connected to the transmission grid (option i). Hence, for generation options ii)-iv), other data sources than NERC statistics have to be taken into account.

In general, there is no comprehensive and commonly accepted database of power statistics,[7] which is why this report uses data from local (NERC, PTFP, National Bureau of Statistics, own surveys) and international sources (World Bank, IEA, United Nations). While efforts were made to validate and harmonize the data, certain deviations across the information depicted in Chapter 3.5 and 3.6 are inevitable.

[7] The National Bureau of Statistics e.g. states that the only source of statistics is essentially PHCN (prior to its unbundling). It comments in this regard: „The PHCN does not have adequate electronic data processing facilities to enable it computerise the production and storage of its administrative statistics. Electricity production and consumption statistics are, therefore, not available in machine-readable form ... „ [23]

The following Chapter 3.5.1 will focus on generation connected to the transmission grid (options i), while Chapter 3.5.2 will further deal with embedded, off-grid and captive generation (options ii – iv).

FIGURE 3 – 4:
POWER GENERATION SITES IN NIGERIA



Source: [Detail; 2015]

3.5.1 Grid-connected Power Generation

TABLE 3 – 3:
ELECTRICITY GENERATION PROFILE

Year	Ave. Gen. availability (MW)	Maximum peak generation (MW)	Maximum daily energy generated (MWh)	Total energy generated (MWh)	Total energy sent out (MWh)	Per Capita Energy Supply (kWh)
2007	3,781.3	3,599.6	77,322.3	22,519,330.5	21,546,192.2	155,3
2008	3,917.8	3,595.9	86,564.9	18,058,894.9	17,545,382.5	120,4
2009	4,401.8	3,710.0	82,652.3	18,904,588.9	18,342,034.7	122,0
2010	4,030.5	4,333.0	85,457.5	24,556,331.5	23,939,898.9	153.5
2011	4,435.8	4,089.3	90,315.3	27,521,772.5	26,766,992.0	165.8
2012	5,251.6	4,517.6	97,781.0	29,240,239.2	28,699,300.8	176.4
2013	5,150.6	4,458.2	98,619.0	29,537,539.4	28,837,199.8	181.4
2014	6,158.4	4,395.2	98,893.8	29,697,360.1	29,013,501.0	167.6

Source: NERC Archive

According to NERC, licenses for on-grid power plants amount to 19,407 MW in 2014. By comparison, off-grid licences cover a production capacity of only 305 MW, while embedded generation capacity represents 49 MW (cf. Annex 3, Table A – 7). At this point it should already be mentioned that electrical power from captive generation is much higher than that provided by power plants with off-grid licenses and embedded generators (see Chapter 3.5.2 for further details).

Figure 3 – 5 illustrates how the licenses for grid-connected generation capacity (options i and ii) are combined. Dark blue represents 'available capacity' and light blue 'non-operational installed capacity'. 13,308 MW installed capacity is attributable to the main power plant fleet, the remainder (~31% of licensed capacity) has not yet been build or is under development. Within the existing power plant fleet, NIPP thermal power plants (~40%) and former PHCN thermal power plants (~34%) are contributing the most installed capacity. According to NERC statistics 80% of actual generation capacity in 2015 comes from gas based power plants, while the remaining energy comes from hydro power plants. For installed capacity the ratio is 84% from gas and 16% from hydro. A detailed overview of the existing power plant fleet is attached in the Annex (cf. Annex 3, Table A – 8).

The existing fleet of power plants is a mix of plants built before the 1990's and plants built (or being built) since the mid-1990's. Since the older thermal power stations suffer considerably from poor maintenance, the available generating capacity was just under 6,200 MW in 2012 and has risen to 6 840 MW in 2015. However, unavailability of gas, breakdowns, water shortages and grid constraints severely limit the power plant performance, which means that despite an increase in the available installed capacity over the last years (see Table 3.3), only between 3000 MW to 4 500 MW are actually being generated (the highest peak generated ever in Nigeria was 4,517.6 MW on December 23, 2012). Up to 2 700 MW of power generation capabilities are regularly lost due to gas shortage,[8] up to 500 MW are lost due to water management, while several hundred megawatts are regularly lost due to line constraints.

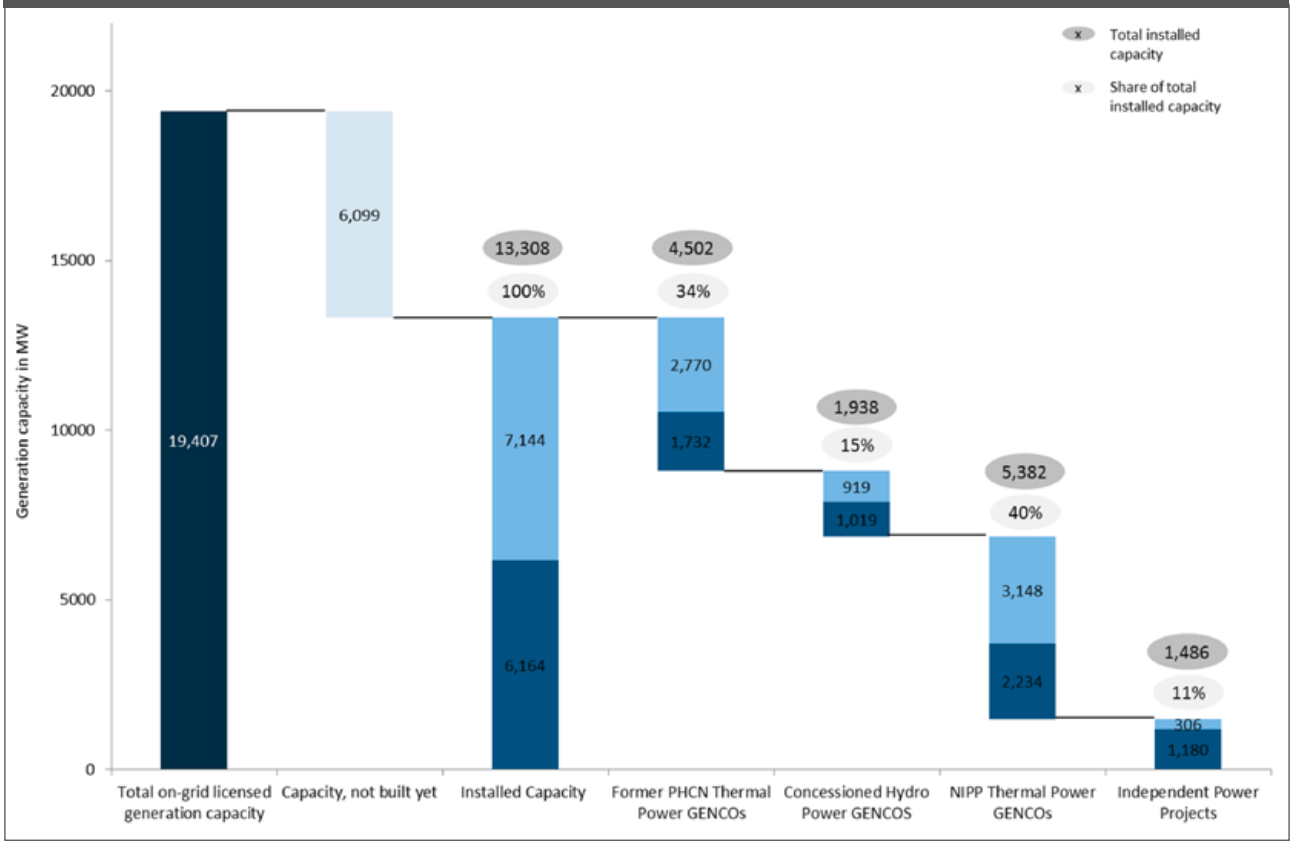
The poor performance of the power plants has led to acute shortage of electricity across the country with power outages of several hours per day.[9] The Presidential Task

[8] Unavailability of gas is mainly due to vandalism of gas pipelines, but also and effect of gas companies rather selling to the more lucrative international market than to the domestic market with regulated prices.

[9] According to GIZ [Mar 2015], businesses tend to suffer about 25.2 electrical outages in a typical month, with an average duration of 7.8 hours, adding up to almost 197 hours of power outages per month (~27% of total hours).

Force on Power regularly publishes the estimated peak demand and peak generation, whereby the former is with 12 800 MW regularly close to four times the latter. The only way the shortfall can be made up is by relying on off-grid electricity generation.

FIGURE 3 – 5:
BREAK-DOWN OF ON-GRID LICENSED POWER GENERATION IN NIGERIA, 2012*



Source: GOPA-International Energy Consultants GmbH
* dark blue = available capacity, light blue = non-operational installed capacity

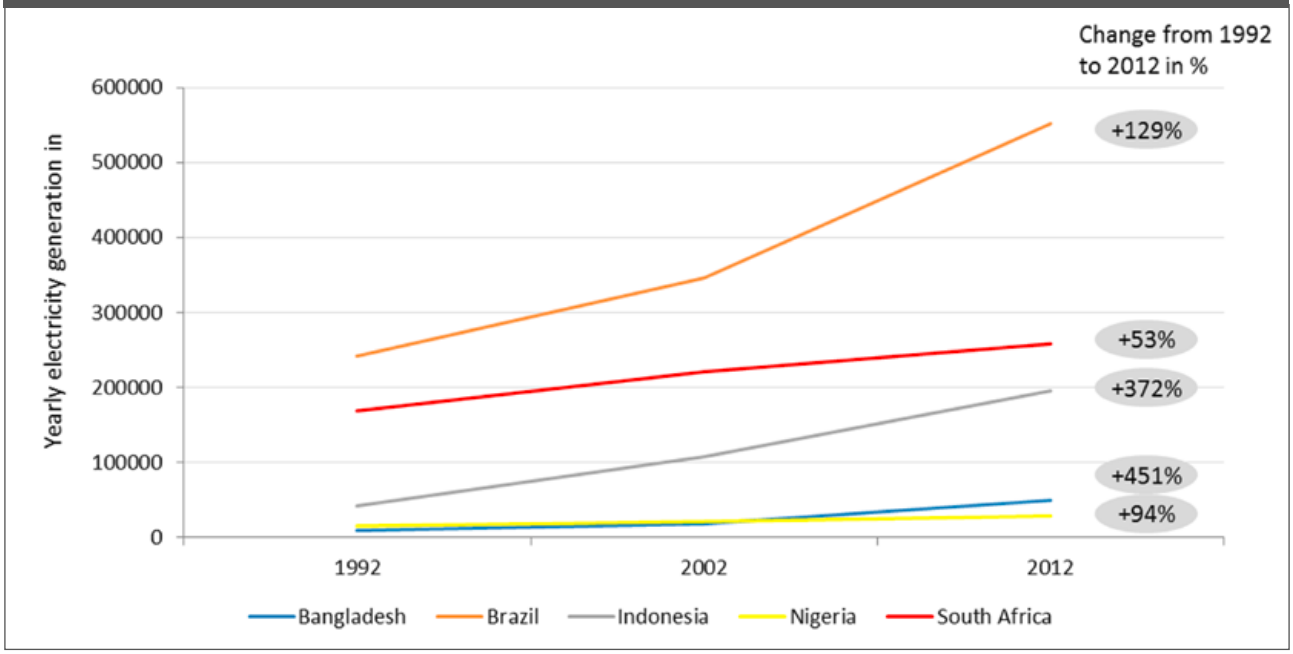
Table 3 – 3 shows that the electricity production stagnated at about 29 000 MWh over the last years, which means per capita generation actually dropped to a very low 167 kWh in 2014.

Figure 3 – 6 shows the historic development of electricity generation in Nigeria and of the prior mentioned peer countries. It can be observed that Nigeria performed worst of the five countries in terms of absolute electricity generation. Over a 20 year period, there was an increase of 93% in mainline generating capacity in Nigeria. By contrast, Indonesia ramped up its electricity production by 372% and Bangladesh even by 451%. As a result, Bangladesh generated almost twice as much electrical energy in 2012 as Nigeria did.

make this possible will be examined in Chapter 6 – On-Grid Renewable Energy.

Two major new gas thermal power plants are being planned at present. One is the Azura Edo Independent Power Producer (IPP) project 459 MW open-cycle gas power plant located in the vicinity of Benin City, in Edo State, Nigeria (Azura). The other is the Qua Iboe IPP (QIPP) 533 MW combined-cycle gas-turbine (CCGT) power plant to be constructed in Ibeno, Akwa Ibom State.

FIGURE 3 – 6:
ELECTRICITY GENERATION (GWH) IN NIGERIA AND PEER COUNTRIES SINCE 1992



Source: IEA, [46]

Going forward, the Renewable Energy Master Plan (REMP) assumes that the energy generation backbone will remain gas, but the percentage accounted for by coal-fired power plants will further increase [ECN; Nov 2012]. While wind will play only a marginal role, solar power production is expected to outstrip all sources of electricity generation other than gas and thus become the second key pillar of energy delivery in the nation. The structure that could

One major hydropower plant is currently under development, the Zungeru 700 MW plant in Niger State. The Gurara 30 MW hydropower plant in Kaduna State and the Kashimbilla 40 MW in Taraba State are two other projects being prioritised by the FGN. Plans to build the 3,050 MW Mambilla hydropower plant in Taraba State have become more concrete since negotiations with the Chinese Exim Bank are ongoing.

In the field of utility-scale solar power projects, there is an array of solar farms that have just obtained licenses or are in the license pipeline. They include a 100 MW facility in Bauchi State, one of 120 MW in Katsina State, and various others in Ekiti, Kaduna, and Nassarawa States. The Ministry of Power has a 10 MW pilot wind plant in Katsina, which is scheduled for commissioning in the near future.

Furthermore, the second phase of NIPPs, focused on building hydro power generation plants, is planned to add 4000 MW of electricity to Nigeria's generation profile (see chapter 4.3. for further details).

Finally, plans are underway to use the domestic coal resources in Enugu und Kogi state for power production purposes; recently, a private company has obtained a license to develop a 1 200 MW power plant.

3.5.2 Off-grid Power Generation

As already mentioned in the previous chapter, off-grid licences cover a production capacity of only 305 MW, while licensed embedded generation capacity only represents 49 MW (cf. Annex 3, Table A-).

However, the majority of private investors active in captive generation usually do so in order to ensure sustainable and stable power supply for their manufacturing facilities. The above listed figures do not account for generation capacity of these privately owned Diesel or gas generators.

According to a 2013 survey, approx. 80% of the Nigerians use alternate sources of electricity supply such as generators or solar inverters.[10] Estimates suggest that between 8 and 14 GW of decentralised diesel generator capacity is currently installed in the country [11]. About 86% of the companies in Nigeria own or share a generator and about 48% of their total electricity demand is covered by these private generators [GIZ; Mar 2015]. With several millions of privately installed Diesel generators, Nigeria leads Africa as a generator importer and is one of the highest importers worldwide, with the total annual import figure being NGN 17.9 billion (US$ 112 million).

Within the Nigerian power system, captive generation offers some distinct advantages. First of all, industrial consumers can generate the power needed for their operations. Secondly, the request for a permit for captive generation involves the least hurdles in terms of financing and regulatory risks. And thirdly, captive generation represents the optimal use of electrical power, since there are theoretically no technical (transmission) or commercial losses to be dealt with.

But there obviously are some major disadvantages. The use of decentralized Diesel generators is economically and environmentally questionable. This is further detailed in Chapter 3.8. Another disadvantage is that a permit for captive generation does not allow for supplying external off-takers. According to [GIZ; Mar 2015], there is an excess of self-generation capacity in the manufacturing sector. Hence, trading between energy surplus and energy negative firms would be beneficial for both, but is coupled with the acquisition of an off-grid or embedded generator license and the management of associated regulatory issues.

In this context the acquisition of an embedded generator license seems more advantageous, since electricity can be evacuated through the existing distribution grid, which makes the acquisition of a distribution license needless. Furthermore embedded generation does not only offer advantages for industrial consumers, but also for states and local governments, which can achieve power supply aspirations within their borders without constitutional constraints. However, the propagation of embedded generation is impeded by missing liquidity of distribution companies, which hinders them to off-take power from potential embedded generators. [Detail; 2012]

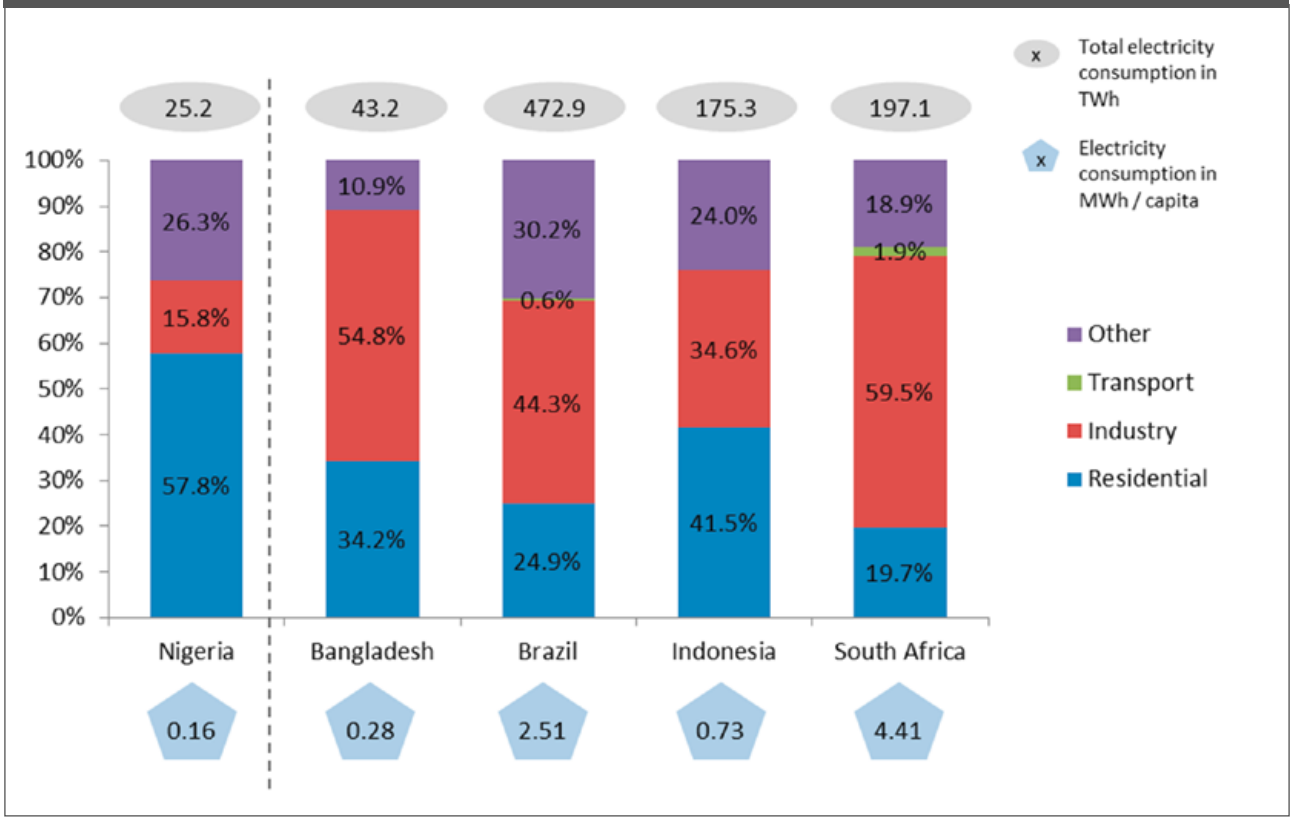
[10] Opinion Polls 47: "Percent of Nigerians Experienced Poor Power Supply in 2nd Quarter of 2013" [45]
[11] GIZ and NIAF estimation

3.6 Electricity Consumption and Demand

3.6.1 Electricity Consumption

The available data on Nigeria for electricity consumption by sector reveals that – similar to energy consumption in general – it is the residential sector that consumes by far the most energy. Figure 3 – 7 illustrates this fact and additionally shows a comparison between Nigeria and the previously defined peer countries.

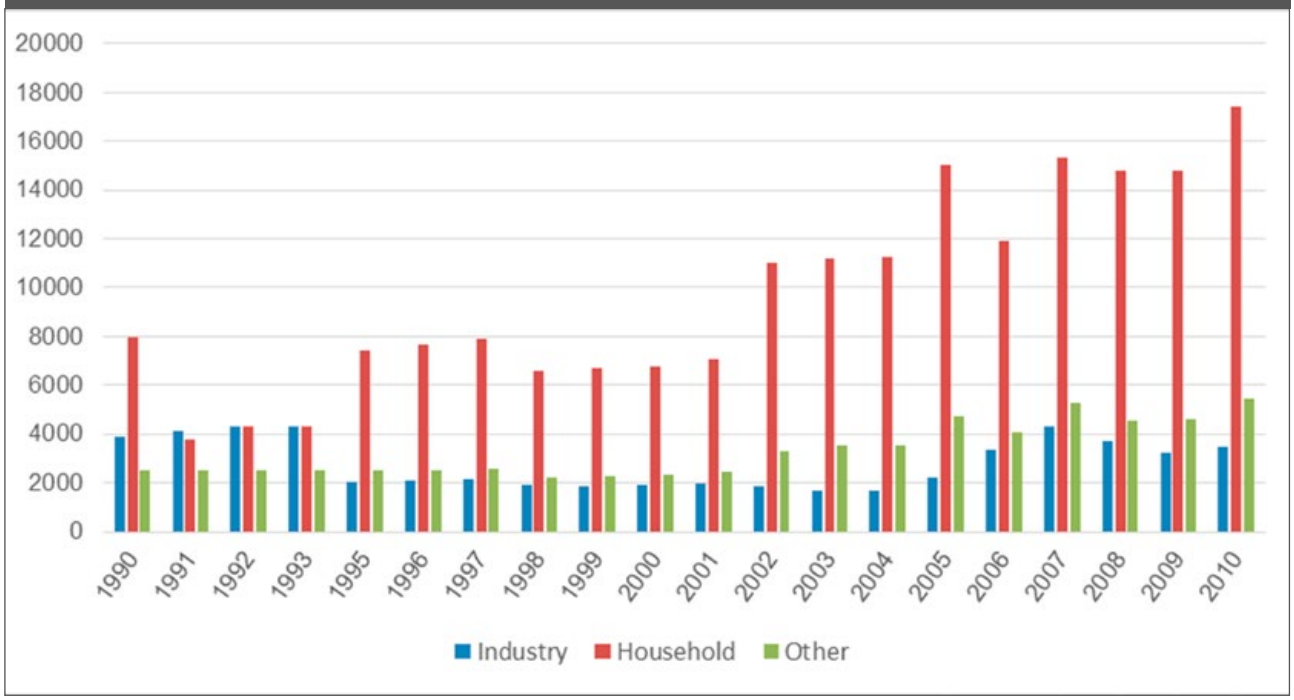
FIGURE 3 – 7: TOTAL ELECTRICITY CONSUMPTION BY ECONOMIC SECTORS AND CONSUMPTION PER CAPITA FOR NIGERIA AND PEER COUNTRIES (2012)



Source: IEA, [46]

Based on data from the International Energy Agency [46], residential usage accounts for almost 58% of the final electricity consumption in Nigeria. Likewise it is the residential sector (households) where the increase over the ten-year period depicted in Figure 3 – 8 is most pronounced.

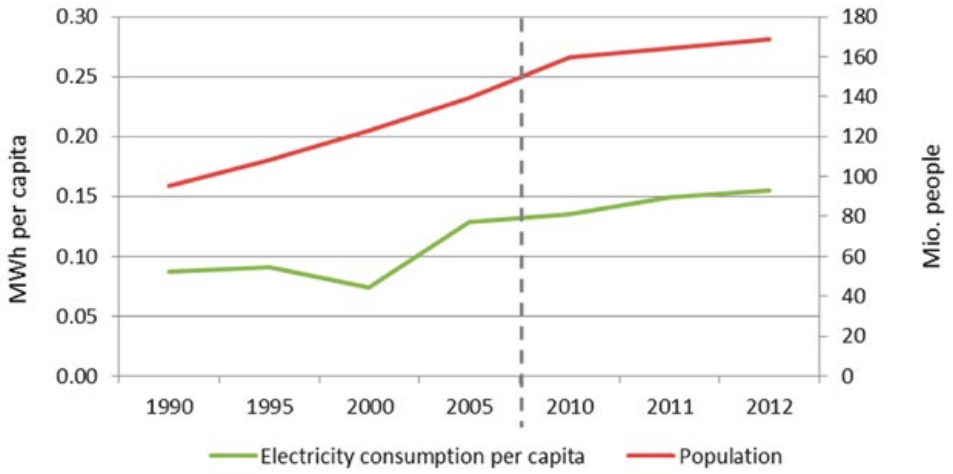
FIGURE 3 – 8:
NIGERIAN ELECTRICITY CONSUMPTION (MILLION KWH)



Source: UN Stats, [62]

All peer countries, represented in Figure 3 – 7, show a significantly lower share of residential electricity consumption accompanied by a much higher share of industrial electricity consumption. In addition to that, overall electricity consumption and electricity consumption per capita are also much higher for the peer countries [46]. However, these figures do not account for captive generation from decentralized Diesel generators, which outstrips the available grid-connected capacities (see Chapter 3.5.2). When taking this privately owned generating capacity into account, the share of industrial consumption is within the range of figures from peer countries. This discrepancy between grid-connected figures and real generation power has to be kept in mind throughout this study.

FIGURE 3 – 9:
HISTORIC DEVELOPMENT OF POPULATION AND ELECTRICITY CONSUMPTION PER CAPITA IN NIGERIA FROM 1990 – 2012



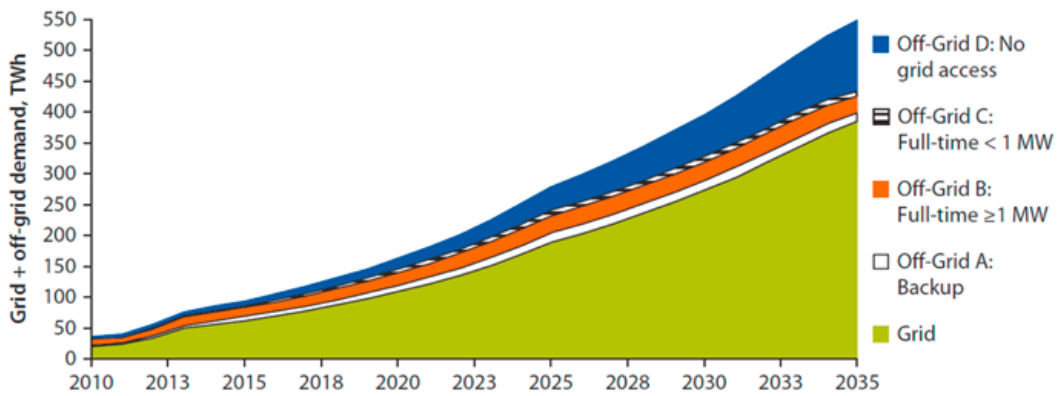
Source: IEA, [46]

Altogether, generation power still seems to lag behind, especially when considering the fact that absolute consumption per capita is the lowest of all countries represented in Figure 3 – 7. Furthermore Bangladesh managed to increase its electricity consumption per capita from 0.05 MWh to 0.28 MWh in the same time period, while experiencing a comparable population growth. This argument is also enforced by Figure 3 – 9, which illustrates the historic development of population and electricity consumption per capita in Nigeria. While population increased constantly between 1990 and 2010, electricity consumption per capita dropped until 2000 – mainly due to a lack of new generation capacity – and only since then started to increase slightly.

3.6.2 Electricity Demand

With a fast population and economic growth, electricity demand is generally expected to increase in the future. The World Bank's demand forecast is illustrated in Figure 3 – 10 [WB; 2013].

FIGURE 3 – 10:
PROJECTED GRID AND OFF-GRID ELECTRICITY DEMAND IN TWH



Source: Calculations based on FMP and Power Holding Company of Nigeria data and UN 2010 rural/urban population data (for off-grid D projections) listed in the chapter 3 references.

Figure 3 – 10 shows a strong increase in the yearly electricity demand, mainly driven by on-grid demand and – from 2020 onwards – also from off-grid demand (blue area, no grid access). According to the World Bank's projection, electricity demand is to grow by a factor of over 5 until 2035 up to almost 530 TWh. This demand could be satisfied by generators with a capacity of ~63 GW, which would have to run throughout the year at maximum output level. Since 100% utilization of all power plants is unrealistic and transmission losses as well as peak power demand are not taken into account yet, even higher generation capacity is necessary for ensuring sufficient supply, if the World Bank's scenario holds true.

Further projections for peak power demand are listed in Table 3 – 4 and can be used as proxy for the required generation capacity. It should be noted that PTFP projections are based on existing infrastructure, considering ongoing and planned projects. Other estimations are based on scenario assumptions regarding population, GDP and structural changes in the economy, which is why the different projections for peak power demand show a big spread. While Agusto & Co. suggests that peak demand will rise to 41,133 MW by the end of 2015 and 88,282 MW by the end of 2020 respectively, Tractebel Engineering performed an independent demand analysis in 2007, and derived a peak power demand of only 11,433 MW in 2020 and 24,208 MW in 2030 [PHCN; 2007]. The Renewable Energy Master Plan [ECN; Nov 2012] provides the most detailed demand projections and estimates a peak power demand in 2020 of approximately 45,490 MW, which lies in the middle of both figures mentioned before [ECN; Nov 2012]. For all cases generation capacity has to be increased significantly, while the huge differences show the importance of a proper demand forecast.

TABLE 3 – 4:
COMPARISON OF ELECTRICITY DEMAND PROJECTIONS (MW)

	2014	2015	2020	2025	2030	2035	2040
Agusto & Co.	12,800	41,133	88,282	–	–	–	–
Renewable Energy Master Plan (reference growth 7%)	–	24,380	45,490	79,798	115,674	161,651	213,122
Presidential Task Force on Power (PTFP)	–	12,800*	–	–	–	–	–
PTFP, distribution capacity	10,648	–	32,774	–	–	–	–
Tractebel Engineering	–	–	11,433	–	24,208	–	–

* www.nigeriapowerreform.org (peak demand forecast, April 2015)

3.7 Electrification

Since the pre-independence era, the Nigerian power supply system has been encumbered by the geographical concentration of generation facilities in the South-South and the related difficulties innate in the transmission system with high losses and load shedding. It has also been burdened with geographical challenges. Electrical energy has to be carried to smaller towns over long distances and through forests without proper protection – and with a high number of illegal connections and all the attendant problems of billing.

TABLE 3 – 5: ELECTRIFICATION RATES IN NIGERIA AND SUB-SAHARAN AFRICA

Region	Sub-Saharan Africa	Nigeria
Population without electricity	621 million	93 million
Overall Electrification rate (%)	32	45
Urban Electrification rate (%)	59	55
Rural Electrification rate (%)	16	35

Source: [IEA 2014]

Reasons for lack of electricity access and frequent blackouts in Nigeria are reported in the General Household Survey of 2010/2011. Over 60% of rural households sampled during the survey attributed the reason for a lack of electricity access to frequent blackouts and high connection cost. Unreliability of service was also reported as one of the reasons for lack of electricity in Nigeria [NBS; 2010/11].

Rural electrification (including off-grid generation), its market, stakeholders and support mechanisms are further dealt with in Chapter 8.

According to the latest available data (cf. Table 3 – 5) the overall electrification rate for Nigeria is just 45 % compared to 32 % average electrification rate in Sub-Saharan Africa. As further detailed in Table 3 – 6 this cannot disguise the fact that there is a sharp discrepancy between cities and rural areas, as the rate of urban electrification in Nigeria is 55 % as compared to only 35 % for rural electrification. Going forward the government plans to achieve an overall electrification rate of 75% by 2025, as emphasized in the "Vision 20:20" and the draft Rural Electrification Strategy and Plan [FMP; 2015].

Table 3 – 6 lists the distribution of households with access to electricity by state. The table shows all households with electricity supply (100%) and the share of the type of supply as a percentage. The table distinguishes between electricity supply by means of PHCN, private generators or solar panels and electricity supply via rural electrification (i.e. mini-grids). As shown in the table, the type of electricity supply varies significantly by state and source. There is a clear North/South divide, possibly attributable to the location of the thermal power stations in the south and the distance involved when wheeling out the power. Figures for those states that have made most progress in rural electrification are marked yellow, while green has been used to highlight states where the reliance on diesel generation was considered exceptionally high. What is also noticeable is that with the exception of a few states, over the period considered, little progress has been made in rural electrification or eliminating reliance on generators – whereby the figures given for generators seem low.

The differences by state can also be read as an indication of market opportunities, since those states where grid-electrification is lowest, or where reliance on PHCN is lowest, are those states where there is the greatest need and therefore, by definition, the greatest potential for investments in rural electrification.

The same source reveals that most rural areas do not have their own generators. In other words, rural electrification was until 2010 at any rate largely left to the informal market, is neither regulated nor structured in a planned manner.

TABLE 3–6:
DISTRIBUTION OF HOUSEHOLDS WITH ACCESS TO ELECTRICITY BY TYPE OF ELECTRICITY SUPPLY IN %, 2010

State	PHCN (NEPA) only	Rural Electrification*	Private Generator	PHCN / Generator	Rural Electricity / Generator	Solar Panel
Abia	89.6	0.9	0.5	5.0	4.1	0.0
Adamawa	89.5	2.9	1.9	4.8	1.0	0.0
Akwa Ibom	82.8	0.4	2.9	13.1	0.8	0.0
Anambra	81.0	1.7	1.0	15.6	0.7	0.0
Bauchi	77.5	8.0	1.4	9.4	3.6	0.0
Bayelsa	33.1	36.1	2.3	2.3	26.3	0.0
Benue	68.5	14.4	2.7	10.8	3.6	0.0
Borno	87.9	6.1	0.0	6.1	0.0	0.0
Cross River	91.7	6.2	0.5	1.6	0.0	0.0
Delta	93.6	2.7	1.5	1.5	0.8	0.0
Ebonyi	78.9	12.7	0.0	1.4	7.0	0.0
Edo	93.1	2.1	1.2	2.7	0.9	0.0
Ekiti	91.1	1.0	0.8	6.9	0.3	0.0
Enugu	75.0	16.9	1.3	5.9	0.8	0.0
Gombe	94.7	3.2	0.0	2.1	0.0	0.0
Imo	85.4	5.0	2.1	7.5	0.0	0.0
Jigawa	93.2	0.9	0.0	4.3	0.9	0.9
Kaduna	84.8	5.1	2.0	7.6	0.5	0.0
Kano	87.0	6.0	0.0	4.0	3.0	0.0
Katsina	80.4	14.7	0.0	4.3	0.0	0.6
Kebbi	86.4	1.6	3.8	7.1	1.1	0.0
Kogi	79.2	3.3	0.4	15.8	1.3	0.0
Kwara	92.8	1.8	0.3	2.4	2.7	0.0
Lagos	67.9	1.2	1.2	25.9	3.5	0.2
Nasarawa	76.0	0.6	7.2	13.2	3.0	0.0
Niger	75.2	1.8	0.9	21.7	0.0	0.4
Ogun	94.5	0.3	0.0	5.2	0.0	0.0
Ondo	87.5	0.8	2.9	2.9	5.8	0.0
Osun	90.5	0.0	0.4	7.1	2.0	0.0
Oyo	97.7	0.9	0.5	0.9	0.0	0.0
Plateau	92.5	1.3	1.3	3.8	1.3	0.0
Rivers	66.0	26.3	6.7	1.0	0.0	0.0
Sokoto	90.4	6.6	0.6	1.8	0.6	0.0
Taraba	85.7	0.0	0.0	14.3	0.0	0.0
Yobe	77.0	6.9	1.1	11.5	3.4	0.0
Zamfara	87.0	6.9	0.0	3.8	1.5	0.8
FCT Abuja	67.4	0.9	1.9	27.6	2.2	0.0
Sector						
Urban	83.2	2.7	0.8	11.3	2.1	0.0
Rural	81.5	7.5	2.0	6.2	2.6	0.1
National	82.2	5.5	1.5	8.4	2.4	0.1

Source: National Bureau of Statistics, 2014

* Rural electrification: Electricity supply via mini-grid, which is not connected with a distribution grid or the transmission grid

3.8 Energy Prices

Nigeria has administratively set maximum prices for kerosene and gasoline and an indicative price for diesel (cf. Table 3 – 7). At the core of this system, which was established in 2003, is the Petroleum Products Pricing Regulatory Agency, which sets these prices every month. The agency applies import parity but is also expected to stabilise prices, which it does with the help of the Petroleum Support Fund (PSF). Consumer subsidies exist for three energy products: gasoline (premium motor spirit, PMS), household kerosene (hhK) and electricity.

3.8.1 Fuel Prices

Crude oil is a globally traded commodity, denominated usually in US dollars; for the purposes of this study, to avoid exchange-rate distortions, quotations will be kept in that currency. Demand for oil is pegged to global macroeconomic conditions and this influences international oil prices. Natural gas prices are less dependent on global trends as there is no world market for gas. Natural gas is traded on more than one regional market with different prices. In the USA, Canada, Great Britain and Japan the price for gas is determined on spot markets. In continental Europe the price of gas is determined by long-term supply contracts with fixed prices. Newly emerging markets for natural gas are China and India, with the Japanese market having changed significantly post-Fukushima and the US market being emphatically altered by the introduction of fracking as a means of tapping in-country gas reserves.

Export prices for Nigerian crude oil correlate with the international market trends. The price has climbed consistently over time, bar the signals seen in crisis years. The US free on board (FOB) price for Nigerian crude oil has risen since 1973 from US$ 7.81 to an initial peak of US$ 38.10 in the 1980's, before steadily climbing since 2001, when the price was US$ 24.85 upward to as much as US$ 114.51 in 2012 [IEA; 2013]. However, between July 2014 and January 2015 the oil price dropped massively from US$ 115 to US$ 45 per barrel, which resulted in a ~28 % drop of Nigeria's revenue (based on Nigeria's gross receipts) [76]. The loss in revenue could only partly be compensated with the reduced government's bills on subsidy (see next paragraph for further details on this).

In the case of petroleum products, the government requires marketers to sell fuel at below market rates. Subsequently paying the difference to petroleum product marketers and licensed importers of fuel. The development of energy prices in the near and distant future depends on political decisions, private investment in the energy sector and world market prices. Realistic figures on the development of prices in the energy sector cannot be given at the moment.

Diesel prices have been deregulated for several years. Government removed the gasoline subsidy on Jan 1, 2012 and allowed the retail price to rise above NGN 140 (US$ 0.88)/ litre or higher. As shown in Table 3 – 7, the fuel subsidy still accounts for a substantial share of GDP and in absolute terms has risen by a factor of seven over the six years covered by the table.

The massive decrease of crude oil prices between July 2014 and January 2015 led to a comparable drop of refined oil prices. According to an article from "This Day Live", at a crude oil price of $115 per barrel, the expected market price of imported petrol is NGN 141 (US$ 0.88) per litre, while the regulated price is NGN 97 (US$ 0.61), translating to a difference of NGN 44 (US$ 0.28) as subsidy. But with the price drop of crude oil to US$ 59.45 per barrel, the government's subsidy spending has been reduced, which led government to lower the regulated price to NGN 97 (US$ 0.61) per litre. [78]

TABLE 3–7:
DEVELOPMENTS IN FUEL PRICES AND FUEL SUBSIDIES, 2006–2012

	2006	2007	2008	2009	2010	2011	2012
Fuel subsidy (bln Naira)	251	290	637	399	797	1,761	1,570
Fuel subsidy (% of GDP)	1.3	1.4	2.6	1.3	2.3	4.7	3.6
Fuel Prices (Naira per litre)							
• Diesel (deregulated)	81	90	118	94	112	152	144
• Kerosene (subsidised)	50	50	50	50	50	50	50
• Gasoline (subsidised)	65	70	70	65	65	65	97

Sources: Nigerian authorities and IMF staff calculations and projections
Note: For 2012, includes one-off payment of about 1% of GDP to settle arrears accrued in 2011.

Gas shortages have been cited by the government as major hindrance to realising the planned power generation. The industry ascribes the shortage of gas for domestic consumption, especially for gas-fuelled IPP's, mainly to the low domestic gas prices compared to the export market and pending approval of the Petroleum Industry Bill (PIB). Although the International Oil Companies (IOC) in Nigeria have an obligation to provide a prescribed percentage of total gas production for domestic consumption this has never materialised, due to the unattractiveness of the domestic market. There are various reasons for the latter, such as poor gas pipeline assets and infrastructure, misaligned funding incentives, theft and vandalism. In August 2014, the Minister of Petroleum Resources announced an upward revision of the gas price from US$1.50 per million cubic feet (mcf) to US$2.50 per mcf, and an additional US$0.80 fee for transport costs (up from US$ 0.30). Such an increase in the gas price may make the national market more attractive for IOCs.

3.8.2 On-Grid Electricity Prices

Since the privatisation process kicked in, electricity prices have been set centrally by the Nigerian Electricity Regulatory Commission in line with its Multi-Year Tariff Order (MYTO). Within the electricity system, DISCOs pay NBET for the electricity they receive from the GENCOs. NBET then pays the GENCOS for the bulk power sent to the grid. Respective prices are fixed per fuel source. For example, the wholesale contract price for a gas power plant is in the order of NGN 10,257 (US$ 64.10) /MWh (2013), whereas the wholesale prices for hydropower, wind, solar and biomass range between NGN 25,400 (US$ 158.75) for hydropower and NGN 73,300 (US$ 458.13) / MWh (2013) for solar PV. On the other hand consumers pay DISCOs for the electricity they consume. Here, prices are fixed per region and consumer category. The price to be paid by the end consumer for electricity in Nigeria is therefore not to be confused with the price paid to the GENCO. This is further detailed in Chapter 4.3.

The MYTO methodology combines the positive attributes of regulating the rate of return and a price cap, which changes by region and type of electricity customer. The regulators factor three modules into the calculation: the allowed return on investment (RoI), the allowed return of capital, and efficient operating costs and overheads. Since the costs factored into the prices are assessed individually for power generation, transmission, distribution and retail, rates differ.

In each instance, in an effort to attract investment in the sector, MYTO emphasises cost recovery and financial viability, whereby the intention is to encourage efficient investments. The multi-year structure provides investors with a firmer basis for planning. Likewise, the tariffs foster an efficient use of the network, as tariffs are destined to reflect the marginal costs users place on the system and boost grid efficiency.

Worthy of mentioning is the tariff design NERC has implemented for DISCOs. It is intended to ensure that a distinction is made between private, commercial and industrial users in regard to electricity prices, while enabling DISCOs to remain commercially viable. Each DISCO has tariffs reflecting its uniqueness in terms of cost, location and customer profile. The Ministry of Finance has provided a maximum subsidy of NGN 50 billion (US$ 312.5 million) (2012 + 2013) solely for residential customers. Moreover, NERC has retained a lifeline tariff at NGN 4.00 (US$ 0.025) / kWh for all those consuming below 50 kWh / month. Cross subsidies from large residential (category R), commercial (category C) and industrial (category D) customers to small residential customers are implicit in the tariff design because the Federal Government subsidy is not sufficient. See [NERC; May 2012] and Table A – 9 in Annex 3.

At present, DISCOs' bills to consumers are made up of two elements: a fixed charge and an energy charge. The former covers capital costs as well as the fixed costs of operation and maintenance across the industry. The latter is charged only when electricity is actually consumed and is intended to cover fuel costs, variable operation and maintenance costs and tax costs to market participants. For example, according to the amended MYTO 2.1 [NERC; Mar 2015], energy charges for residential usage [12] range between NGN 14.96 and NGN 20.89 (US$ 0.094 – 0.131) /kWh with fix charges ranging between NGN 625 and NGN 800 (US$ 3.91 – 5.00) / month, depending on the region (DISCO). As already mentioned, these ranges differ for other types of consumers. For an exhaustive list of the different sub-categories of the main classes (residential, commercial, industrial, special, and street lighting) please see Annex 3, Table A – 9; for the full tariff schedule of two selected DSICOs see Table A – 10.

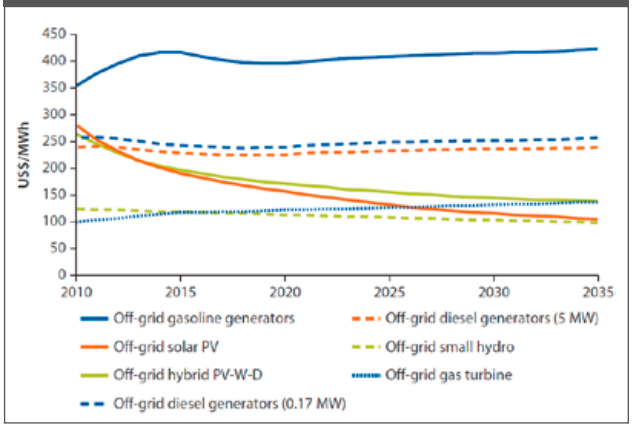
At present, the individual DISCO business plans indicate that aggregate technical, commercial and collection (ATC&C) losses over a five-year period for the distribution companies are assumed to be between 35 – 40%, while technical and commercial losses alone range between 12.0% and 28.4%. The various DISCOs have committed to lower that figure markedly [WB; 2014]. The technical and commercial losses are also factored into the amended MYTO 2.1 conditions for DISCOs, with losses as a percentage of distributed energy being expected to fall. With the introduction of MYTO 2.1 in December 2014, prices for electricity increased by about 80%. Petitions by various consumer groups, evoked by this electricity price increase, led to amendment of MYTO 2.1 and a price drop of ~50%. According to NERC, the main reason for the dramatic price increase was that the collection losses was passed on to the consumers. In the amended MYTO 2.1 NERC considers, "in the public interest and fairness, the level of Collections Losses (amount billed but not collected by the DISCOs) as imprudent to be passed on to consumers since it is fully within the control of the DISCOs to collect their bills. Therefore, for the purpose of the level of loss allowable to pass through to consumers, the Collection Loss has been set at zero ..." [NERC; Mar 2015].

3.8.3 Off-Grid Electricity Prices

The projected prices for off-grid electricity can be seen in Figure 3 – 11 [76]. In the present set-up of the Nigerian electricity market, off-grid generation based on medium-sized diesel gensets is by nature far more expensive for the consumer than on-grid supply of electricity. The World Bank estimates the cost for generation with medium-sized diesel gensets at approx. 250 US$/MWh (corresponds to NGN 40 (US$ 0.25) / kWh). This is significantly higher than the electricity charges for residential usage[13] and also higher than electricity charges of NGN 19.89 – NGN 29.58 (US$ 0.124 – 0.185) /kWh for industrial usage[14], purchased from the DISCOs based on MYTO 2.1 [NERC; Mar 2015]. Small scale businesses and families spend an average of NGN 3.5 trillion (US$ 21.8 billion) yearly to power their generating sets with diesel and petrol due to unstable supply of electricity [65].

[12] Category R2, single phase and 3 phase
[13] See above
[14] Category D1, single phase and 3 phase

FIGURE 3 – 11:
OFF-GRID ELECTRICITY PRICES



Sources: ESMAP 2007; IEA 2010a

The striking element in Figure 3 – 11 is the clear projected decrease in the price of electricity generated by solar PV, which is expected to fall to a level similar to that for small hydropower plants, with the cost of diesel/solar hybrid systems falling by equal scale.

Notably, to date solar PV is already substantially cheaper than electricity produced using diesel generating sets. This especially is the case in areas a long distance from diesel depots – which includes most of northern Nigeria. This trend seems to be persistent, considering various international predictions of the PV prices in comparison to other means of power generation. As shown in Chapter 3.8.1, fossil fuel prices particularly in Nigeria are expected to rise more than in other (comparable) economies, due to expected cuts in subsidies. Taking this into consideration, solar PV plants broke even with diesel generating set much earlier than predicted in the Energy Sector Management Assistance Program (ESMAP) 2007 study. Solar PV/diesel hybrid systems can thus be expected to gain sway over time.

3.9 Transmission and Distribution Sector

The privatisation exercise of NEPA was concluded by the Bureau of Public Enterprises (BPE) and the Bureau of Public Procurement (BPP) in 2013 – 2014 by unbundling the successor companies into 11 distribution companies and 6 generation companies, cf. Chapter 3.4. The Government only retained control of the transmission and system operation under the Transmission Company of Nigeria (TCN). The transmission lines and generators are interconnected in a common grid, with a single control centre at Oshogbo. Thus, the government bears the cost of high voltage grid expansion and encourages private investors to focus on generating capacity. Distribution companies are responsible for the expansion of medium and low voltage distribution grids.

3.9.1 Transmission

The National Grid operates at 330 kV and 132 kV high voltage level (HV). In 2010, more than 12,300 km of transmission lines (5,523 km of 330 kV and 6,801 km of 132 kV) connecting 32 330 kV and 105 132 KV substations were operational. At the current configuration (2014) the national grid has an installed capacity of 6,500 MW but can handle a wheeling capacity of maximum 4,500 MW [Dagogo-Jack, R. B.; 2014]. The ongoing NIPP transmission projects will further boost the wheeling capacity by 1,300 MW. The long-term planning of TCN is to further improve the grid capacity – thereby topping the installed generation capacity – to 10 GW by 2014, 16 GW by 2017 and 20 GW by 2020 as further detailed in Figure 3 – 12, Figure 3 – 13 and Figure 3 – 14. However, by April 2015, the proposed system enhancements shown in Figure 3 – 13 are under construction but not yet completed.

The Nigerian national grid is characterised by the poor voltage profile in the network (especially in the north due to its radial nature) and is constrained by limited control infrastructure. Overloaded transmission lines and high

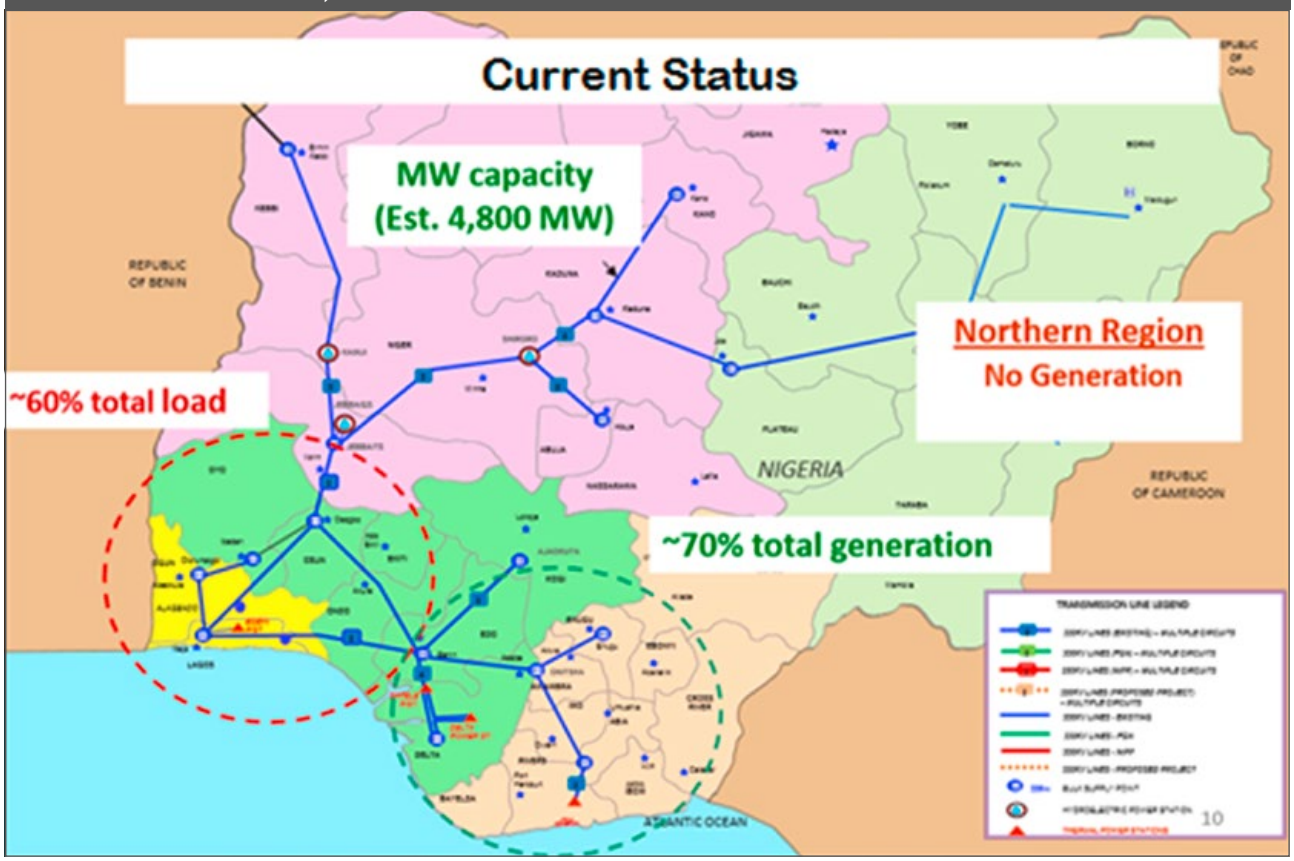
technical and non-technical losses are a regular feature. [NERC; Feb 2011]. Transmission and distribution losses combined are estimated at 17 – 20% [15]. The first 15 months after privatization saw 20 system collapses.

As per the Amended MYTO 2.1, he current wheeling charges ("TCN Tariff") amount to NGN 2 743 (US$ 17.14) per MWh.

There are 3 key issues facing the improvement in the national grid.

- Establishing a clear plan for operational enhancement to reduce technical and commercial losses.
- Full market integration of TCN in order to operate as credit-worthy industry participant.
- A comprehensive assessment and clean-up of TCN's project portfolio to enable the completion of several ongoing and stranded projects.

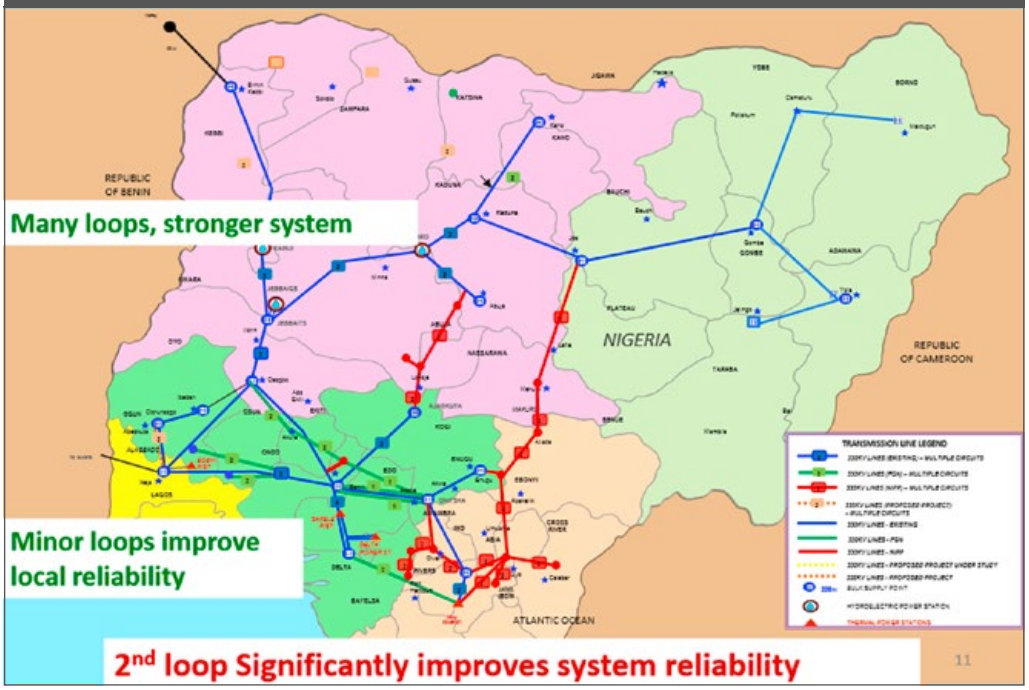
FIGURE 3 – 12:
EXISTING 330 KV RADIAL GRID, 2013



Source: [TCN; 2013]

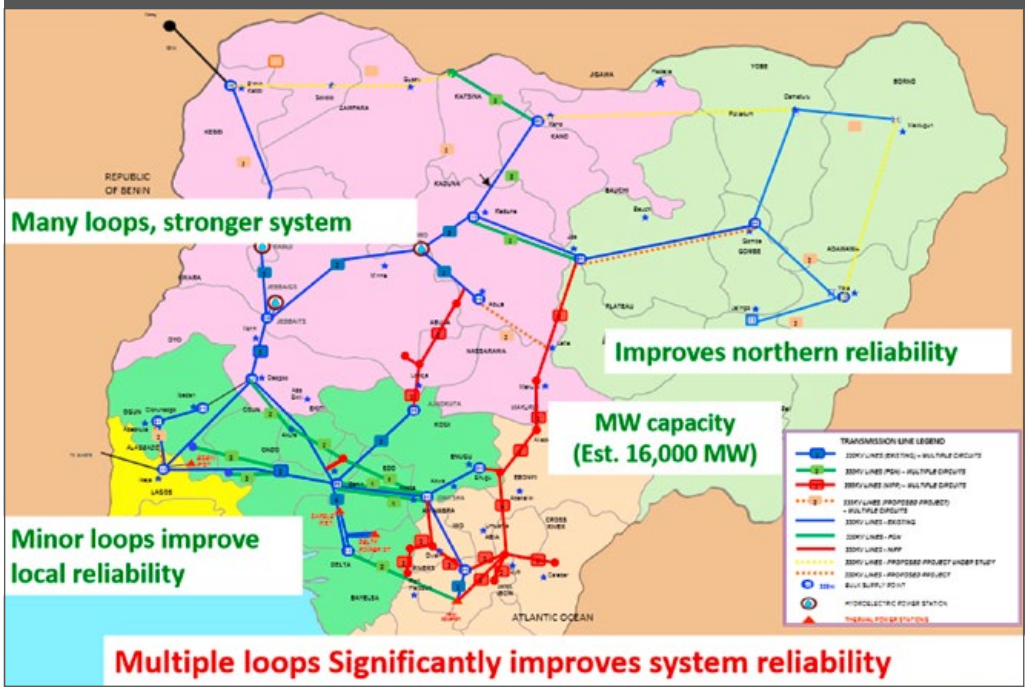
[15] TCN archive (supported by NIAF)

FIGURE 3 – 13:
330 KV TRANSMISSION GRID FOR WHEELING 10,000 MW, END OF 2014



Source: [TCN; 2013]

FIGURE 3 – 14:
330 KV TRANSMISSION GRID FOR WHEELING 16,000 MW, END OF 2017



Source: [TCN; 2013]

3.9.2 Distribution

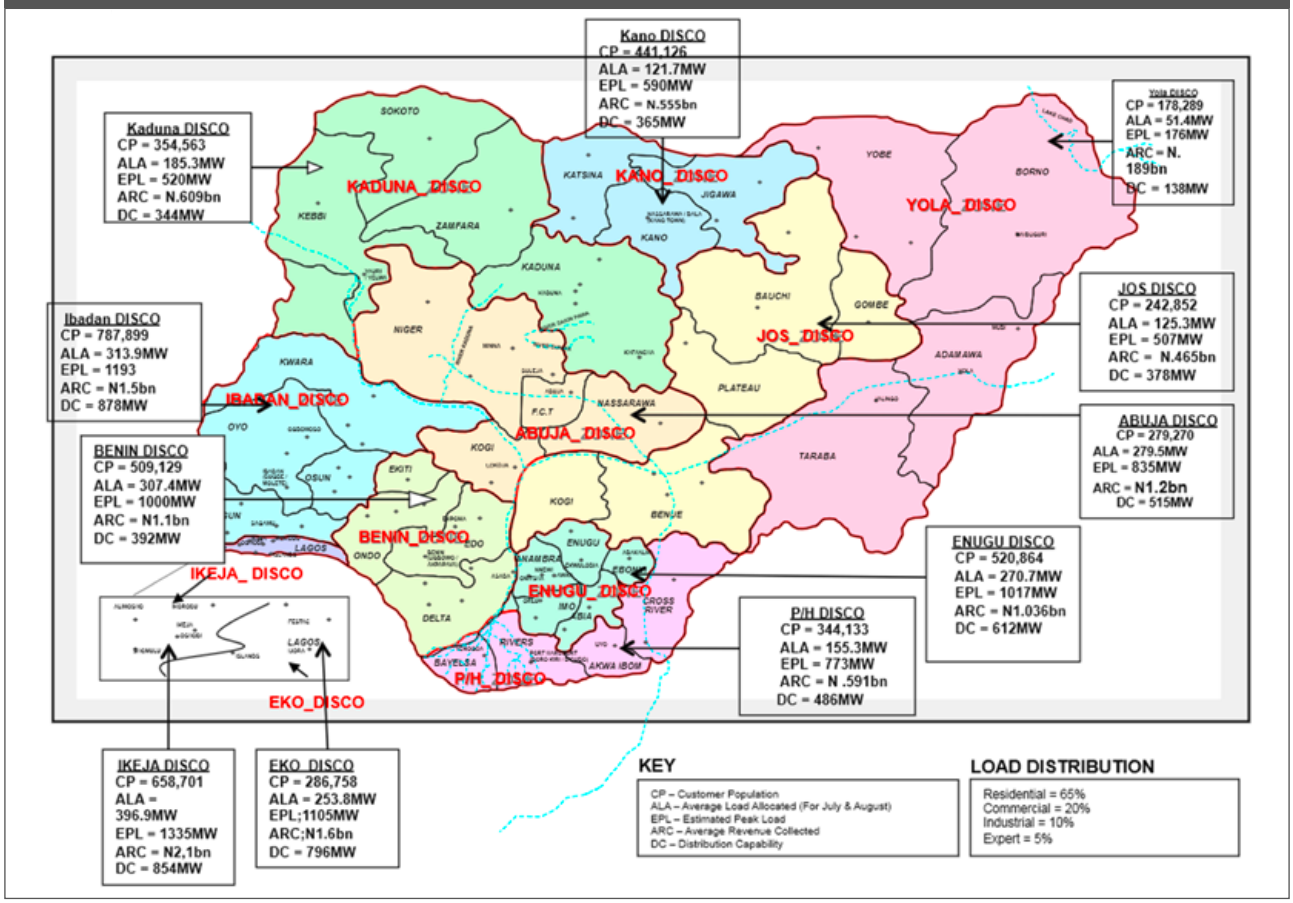
The distribution grid operates mainly on 33 kV and 11 kV level, i.e. medium voltage (MV) and low voltage level (LV). In 2010 more than 24,000 km of distribution network were available [NERC; Feb 2011].

Figure 3 – 15 shows the geographical areas covered by the respective distribution companies as well as the mega-wattage allocated to them. The north/south divide is readily apparent from the ratio of population to megawatts, whereby within the north there is a sharp discrepancy between the mega-wattage allocated to the northeast, and that to the central and western sections of the region. The companies are generally owned by consortia. In some cases these include larger state governments. The 11 distribution companies are: Abuja, Benin, Eko, Enugu, Ibadan, Ikeja, Jos, Kaduna, Kano, Port Harcourt, Yola.

During the privatisation process preferred bidders were identified, based on the determination "of the most aggressive but feasible loss reduction trajectory over a 5 year period" [NERC; Mar 2015].

The distribution code innate in the power sector privatisation policy is not specific about off-grid or mini-grid networks. The general assumption is that it does not apply to them, giving a greater scope to investors in such areas. The distribution code is further detailed in Chapter 5.5.1.2. Independent Electricity Distribution Networks (IEDNs) represent an efficient way of supplying areas with electricity which are not connected to the national grid or a distribution grid [Detail; 2012].

FIGURE 3 – 15:
THE DISTRIBUTION COMPANIES´ MARKETS



Source: Securities & Exchange Commission, Nigeria, [53]

With the privatisation of the power sector, the composition of its stakeholders has changed markedly. From the inception of the interim market onwards, the main stakeholders in the sector are and will be private entities, with government retaining the role of regulator and grid operator only. The World Bank still acts to provide the Federal Government with a partial risk guarantee to cover possible defaults in the system in the event of NBET not being able to pay a generating company during the lifetime of the interim market [African Development Fund; 2013]. Public-sector players still active in the market tend to be those states that have acquired or are acquiring shares either in distribution companies or in independent power plants. NGOs and international donor organisations' activities are mainly focused on supporting policy-making, energy efficiency and renewable energy projects. Development Finance Institutions (DFIs) are involved in various cases in debt financing for larger power plants. With the restructuring of TCN there is renewed participation by DFIs in transmission sector upgrades and expansion.

Because of the hitherto non-commercial nature of the sector, activities by public institutions have tended to be the primary driver of rural electrification (RrE), energy efficiency (EE) and renewable energy (RE) initiatives in Nigeria to date. Until October 2013 the Federal Government of Nigeria had the largest stake in the energy and power sector of the country, thus making private investor involvement limited and also posing the challenge to policymakers to create an investor-friendly climate in a domain not known for its short-term commercial viability. The role of regional and international institutions on the other hand is based on developmental needs and strictly non-commercial. For details on the privatisation process see Chapter 3.

A key advantage of the present structure is that it enables the federal government to take the lead in pursuing clean technologies and promoting a diversified electricity mix. Given the paucity of the power sector per se, Nigeria can potentially avoid the pitfalls industrialised nations faced when fast-tracking the use of renewables. Nevertheless, the distribution and the generation companies will play as important a role as the central government does. The current institutional arrangements are discussed in detail in a study published by GIZ in November 2013 and entitled "Institutional and Policy Mapping of the Renewable Energy, Energy Efficiency and Rural Electrification Subsectors in Nigeria". [GIZ; Oct 2013].

The present chapter will provide a concise synopsis of the major actors in the Nigerian energy sector.

4.1 National Public Institutions

The following chapters summarise the major national public institutions active in the energy market. Stakeholders will also be mentioned in Chapters 6, 7 and 8 whenever applicable.

4.1.1 Federal Ministry of Power

The liberalization of the power market has resulted in a change in the needs of the sector. As a consequence, the Federal Ministry of Power (FMP) is now undergoing a restructuring process that will allow it to adapt to the new environment. In this context, a new department entitled "Renewable and Rural Power Access" was created.

The FMP is responsible for ensuring the establishment of a robust power sector that fully supports the socio-economic needs of the nation. The main goal of the FMP is directed at initiating, formulating, coordinating and implementing broad policies and programmes promoting the development of electricity generation from all sources of energy.

The Honourable Minister of Power heads the Ministry, while the Honourable Minister of State is in charge of the operational activities, and the Permanent Secretary is the accounting officer. The latter two offices are supported by seven departments and five units. They are responsible for the promotion of all forms of electricity generat-

ed from both renewable energy and other non-renewable energy sources. In order to facilitate diversification of the nation's energy mix, the ministry is encouraging the use of renewable energy sources for power generation, especially in rural areas of the country. The ministry convenes the Inter-Ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE), has commissioned some solar power pilot projects in Ogun and Cross River states, and is building a pilot wind farm in Katsina. [11] The REA, EMSL and NAPTIN are affiliated to the FMP, whereby the ministry oversees the independent regulator NERC (see below).

4.1.1.1 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) was established as an independent regulatory agency in 2005 under the EPSR Act 2005. Its mandate is to monitor and regulate the electricity industry of Nigeria, and ensure compliance with market rules and operating guidelines.

NERC in its function as market regulator shall ensure fair and competitive electricity trading. It is instrumental in providing a 15-year tariff path which undergoes major reviews every six years with minor reviews biannually. As part of its mandate NERC has at present set the Multi Year Tariff Order (MYTO 2.1) which defines generation and consumer offtake prices.

Moreover, and crucially, NERC is responsible for assessing applications for licenses to operate an independent power plant larger than 1 MW, and thus approves eligibility of the company in question to negotiate a power purchase agreement with the central off-taker in the current transitional market, the Nigerian Bulk Electricity Trading Plc (NBET).

In order to create an enabling investment climate for rural electrification projects, NERC is currently elaborating regulatory guidelines for mini-grids less than 100 kW and a light-handed regulation for mini-grids between 100 kW und 1 MW.

The commission also plays a key role in consumer protection by developing customer service standards and fair pricing rules. NERC also provides effective dispute resolution mechanisms.

4.1.1.2 Rural Electrification Agency of Nigeria (REA)

Nigeria's Rural Electrification Programme was launched in 1981 aiming at connecting all local government headquarters and selected neighbouring towns and villages to the national grid. The Federal Ministry of Power and Steel in collaboration with the Power Holding Company of Nigeria (PHCN) handled the rural electrification activities centred on grid extensions. They were substituted by the Rural Electrification Agency (REA), which was established in 2006 as part of the Electric Power Sector Reform Act (EPSRA).

REA's core function is to coordinate rural electrification activities in Nigeria and to manage the Rural Electrification Fund. Until recently, the REA has been implementing electrification projects on its own with a focus on grid extension. Most recently the agency has broadened its scope to include the deployment of off-grid renewable energy systems to accelerate the pace of improvement. [Montgomery, E.; 2012]

The REA provides overall support and coordination of rural electrification activities of various stakeholders such as public -private partnerships, private investors and community owned/operated projects. REA through its offices in each of the six geopolitical zones conducts feasibility surveys, market surveys, and willingness to pay surveys to ensure easy offtake. The REF Management Directorate of the REA is responsible for establishing and administering the Rural Electrification Fund to provide capital subsidies in a clear and transparent competitive process, to qualified rural electrification schemes developed by public and private sector entities.

Since 2013, REA's role is transitioning from centrally managed and government-funded projects, towards a demand-driven (yet still centrally coordinated) market approach. The REA does not have any regulatory mandate.

4.1.1.3 Electricity Management Services Limited (EMSL) of Nigeria

The Electricity Management Services Limited (EMSL) of Nigeria is a governmental agency under the FMP providing support services to the electricity generation, transmission and distribution sector in Nigeria. It is set up to guarantee efficient and reliable production and delivery of power as well as the safety of lives and property in the electricity sector.

EMSL inspects, tests and certifies electrical materials, equipment, power systems and electrical installations of the Nigerian power industry. Installations are tested for their adherence to technical standards and regulations.

Furthermore, EMSL provides advanced trainings for technicians as well as licensing of technical personnel.

After the imminent adoption of the NEMSA Act, EMSL will be renamed into Nigerian Electricity Management Services Agency (NEMSA).

4.1.1.4 National Power Training Institute of Nigeria (NAPTIN)

As a response to the massive training needs in the power sector, the National Power Training Institute of Nigeria (NAPTIN) was established in March 2009. NAPTIN directly reports to the FMP and operates from its headquarter in Abuja eight regional training centres in Afam, Akangba, Ijora, Jos, Kaduna, Kainji, Kano and Oji.

So far, NAPTIN has focused on government-funded technician training courses. Flagship programmes include the National Graduate Skill Development Programme (NGSDP) and the National Power Sector Apprenticeship Scheme (NAPSAS), the latter aiming to train 7 400 graduates in a broad range of technical power professions.

In order to maintain its position as a one-stop-shop training institute for the privatized power sector, NAPTIN increasingly intends to adopt a private-sector driven approach in its operations.

4.1.2 Federal Ministry of Environment (FMENV)

The Federal Ministry of Environment (FMENV) was established in 1999 with the statutory responsibility of protecting the environment against pollution and degradation and to ensure the conservation of natural resources for sustainable development in Nigeria. FMENV is also charged with coordinating all climate change matters under its Department Of Climate Change. The department represents the Ministry at international climate negotiations.

The Department Of Climate Change follows the objective to foster renewable energy and energy efficiency. It thereby mainly focuses on the sustainable use of biomass for cooking purposes and small scale agricultural applications.

The FMENV is also the regulator for the Environmental and Social Impact Assessment (ESIA). ESIA are mandatory for all development projects as per the Nigerian EIA Act No. 86 of 1992.

Its roles in renewable energy and rural electrification are further detailed in Chapters 6.2 and 7.4, respectively.

4.1.3 Federal Ministry of Science and Technology (FMST)

The Federal Ministry of Science and Technology develop and implements strategies for science and technology development in Nigeria.

The ministry consists of five technical departments, each specialising in a certain field of science and technology: Science and Chemical Technology Department, Renewable and Conventional Energy Technology Department, Technology Acquisition, Adaptation and Promotion Department, Biomedical Science, Health and Environmental Technology Department and Bio resources Department.

The Renewable and Conventional Energy Technology Department is responsible for energy issues in the FMST. The focus lies on nuclear, renewable and alternative energy sources as well as energy efficiency and R&D activities addressing energy-related problems associated with environmental degradation, pollution and climate change. Roadmaps are being designed aiming at further integration of renewable energy into the existing energy mix. Furthermore, the ministry manages energy statistics.

In this function, the FMST also oversees the Energy Commission of Nigeria and the National Agency for Science and Engineering Infrastructure

4.1.3.1 Energy Commission of Nigeria (ECN)

Established in 1988, the Energy Commission of Nigeria (ECN) is "charged with the responsibility for the strategic planning and co-ordination of national policies in the field of energy in all its ramifications" (ECN Act). This includes advisory services to the government on energy strategies, preparation and dissemination of information, promotion of research, development and training, as well as liaising with international energy-related organisations.

Energy research, development and training related activities are carried out in the six technical departments and the six energy research centres. Two of the centres, located at Nsukka and Sokoto, are responsible for new and renewable energy research. The centre in Lagos focuses on energy efficiency and conservation, while the centre in Benin City specialises in energy and environment. The two centres in Ilorin and Bauchi are responsible for hydropower research and research in the area of petroleum respectively.

ECN was instrumental in launching the Renewable Energy Master Plan (2102). Another significant contribution was the preparation of the first National Energy Policy launched in 2003. This policy is currently under revision.

The roles of ECN in the RE, EE and RrE sectors are further outlined in Chapters 6.2, 7.4 and 8.2, respectively.

4.1.3.2 National Agency for Science and Engineering Infrastructure (NASENI)

The federal government has established the National Agency for Science and Engineering Infrastructure (NASENI) in 1992. NASENI promotes local manufacturing of renewable energy technologies such as solar modules, small hydro turbines, pole mounted transformers and wind turbine blades.

4.1.4 Federal Ministry of Lands, Housing and Urban Development (FMLHUD)

The Federal Ministry of Lands, Housing and Urban Development (FMLHUD) aims at providing adequate housing for all Nigerians in a conducive and liveable environment. This includes the design of urban development plans as well as the implementation of public housing programmes. The ministry furthermore is the driver of building-related policies and has the power to enforce regulations in the building sector. It thus plays a strategic role regarding energy efficiency in buildings which it lives up to by e.g. including energy aspects in the ongoing review of the building code (see also Chapter 7). The state ministries of housing can play an equally important role at state level.

The FMLHUD supervises the activities of the Federal Housing Authority (FHA), the Federal Mortgage Bank of Nigeria (FMBN), and the registration boards of the rele-

vant professional bodies. [9] The role of the FMHLUD in promoting Energy Efficiency will be further discussed in Chapter 7.

4.1.5 Federal Ministry of Water Resources (FMWR)

The Federal Ministry of Water Resources (FMWR) was created in its current form in April 2010 with the mission to provide sustainable access to safe and sufficient water to meet the socio-economic needs of all Nigerians through efficient water resources management for basic human needs, irrigated agriculture, hydropower generation and the promotion of a healthy population while maintaining the integrity of fresh water bodies.

Through the Department of Dams and Reservoir Operations, the FMWR is involved in numerous hydropower projects. While the FMWR handles civil works and issues water licenses, the Ministry of Power oversees the power generation aspects of the projects. To date, ministry has carried out studies on some hydropower projects as further detailed in Chapter 6.1.2.

4.1.6 Federal Ministry of Industry, Trade and Investment (FMITI)

The Federal Ministry of Industry, Trade and Investment has the mission to create an economic environment in Nigeria that attracts investments, advances the industrialization process and expands trade and export in order to strengthen the domestic economy.

Among other sectors the FMITI supervises products, processes and companies in the energy industry and supports and enacts renewable energy and energy efficiency measures. It oversees the production of component parts of solar panels and is responsible for policies regarding blending of biomass and provides industry incentives for renewable energy applications.

4.1.6.1 Standards Organisation of Nigeria (SON)

The Standard Organisation of Nigeria (SON) is a federal government entity affiliated to the FMITI tasked with the responsibility of ensuring that all products (imported and manufactured in Nigeria) adhere to stipulated standards.

The functions of the SON include [55]:

- preparing Nigerian Industrial Standards and ensuring the compliance of products and methods with such standards;
- establishing a quality assurance system including certification of factories, products and laboratories;
- fostering interest in the formulation and adherence to standards by industry and the general public
- assessing the conformity of imported products in the port of origin (pre-shipment verification)

The SON has developed and/or adopted some standards on renewable energy and energy efficiency recently. Among these standards are a code of practice for the deployment of outdoor solar lighting, design qualification and type approval of PV modules, safety standards for use of PV power converters, etc. The current list of SON standards is attached hereto in the Annex 4, Table A – 11.

4.1.7 Nigerian Bulk Electricity Trading Plc (NBET)

The Nigerian Bulk Electricity Trading Plc (NBET) is a government owned public liability company. The Bureau of Public Enterprises and the Ministry of Finance are its two shareholders of record with 80% and 20% stakes respectively.

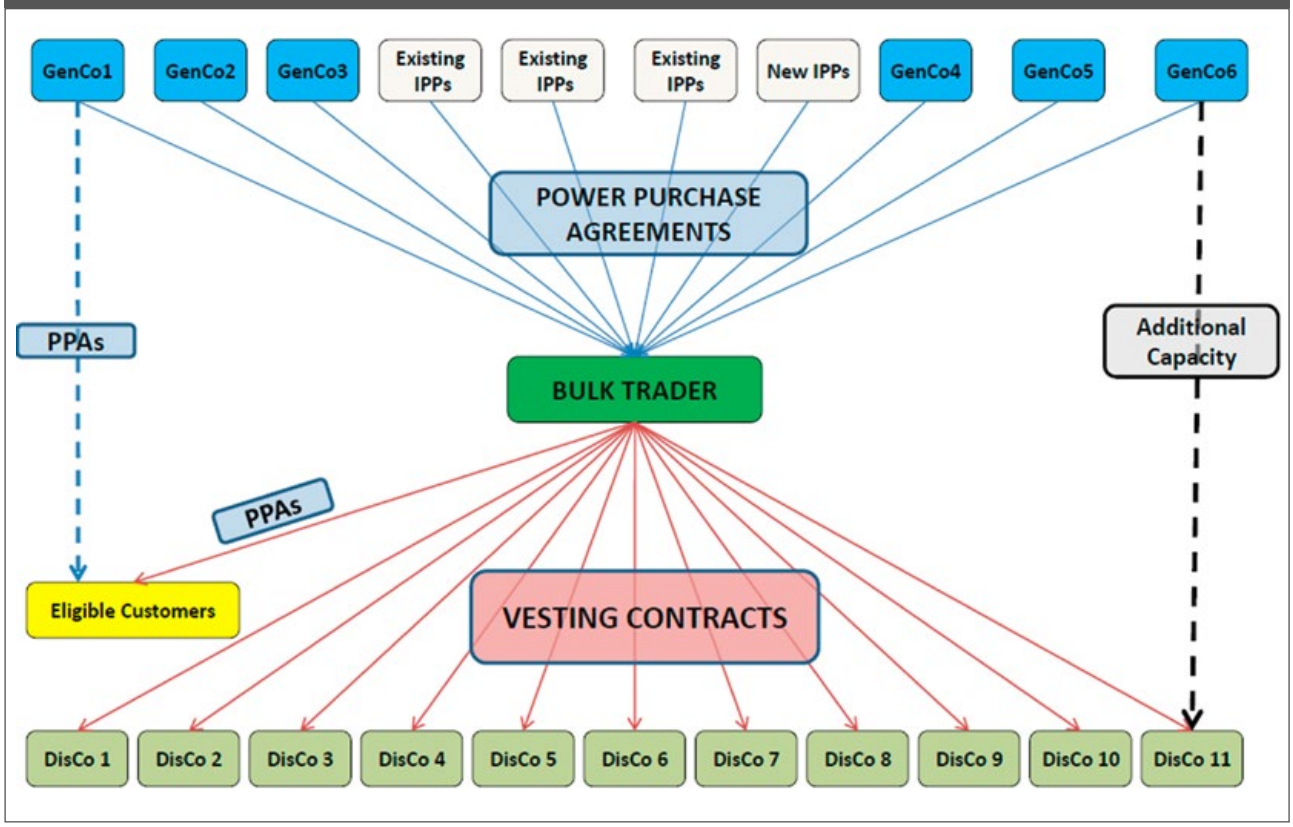
NBET was established in 2010 in line with provisions of the Electric Power Sector Reform Act (EPSRA). It is a trading licensee holding a bulk purchase and resale license. Its mandate is to engage in the purchase and resale of electricity and ancillary services from independent power producers and from the successor generation companies.

The transitional market trading arrangement is depicted in Figure 4 – 1. NBET signs PPAs with privatised generation companies, greenfield IPPs and existing state-owned

power plants. They resell power via vesting contracts with distribution companies and sign power sales agreements with eligible customers directly. NBET's power purchase agreements (PPAs) with independent power producers are backed by credit enhancement instruments provided by the FGN.

In 1988, the corporation was commercialised into 11 strategic business units, covering the entire spectrum of oil industry operations: exploration and production, gas development, refining, distribution, petrochemicals, engineering, and commercial investments. NNPC by law manages the relation between the Nigerian federal government and

FIGURE 4 – 1:
NBET, TRANSITIONAL MARKET TRADING ARRANGEMENT



Source: [Wonodi; 2013]

4.1.8 Nigerian National Petroleum Corporation (NNPC)

NNPC has sole responsibility for upstream and downstream developments in the oil industry, and is also responsible for regulating and supervising the sector on behalf of the Nigerian government. NNPC was established in 1977 as a merger of the Nigerian National Oil Corporation and the Federal Ministry of Mines and Steel.

a number of foreign multinational corporations. Through collaboration with these companies, the Nigerian government conducts petroleum exploration and production.

Regarding renewable energy and energy efficiency, NNPC explores the use of biofuels (mainly ethanol and biodiesel) for mixing with conventional fuel and seeks to reduce its internal consumption.

4.1.9 Presidential Task Force on Power (PTFP)

The Presidential Task Force on Power (PTFP) was constituted in order to drive the implementation, monitoring and performance evaluation of the power reform agenda. The PTFP's mandate covers the development of the Roadmap and the provision of effective technical support to the sector reform agenda. Furthermore, it acts as inter-agency interface to ensure that every milestone in the power sector reform roadmap is accomplished.

The Technical Board [16] of the PTFP brings together all the reform project stakeholders that have a role to play in removing legal and regulatory obstacles to private sector investment in the power industry. PTFP also has the mandate to monitor the planning and execution of various short-term projects in generation, transmission, distribution and fuel-to-power which are critical to meeting the service delivery targets in the power sector reform roadmap. [PTFP; 2013]

4.1.10 Nigerian Governor's Forum (NGF)

The Nigeria Governors' Forum (NGF) is an association wielding significant political influence that brings together the governors of the 36 federal states of Nigeria. It aims at promoting a cross-state platform to discuss public policy issues and share experience on good governance. Further, the NGF aims to enhance cooperation at state level. The vision of the NGF is to be a non-partisan forum promoting democratic values, good governance and sustainable development in Nigeria.

4.2 Role and Functions of States and Local Governments

As is the case in other countries, the Nigerian constitution distinguishes between exclusive national, state and local competencies as well as concurrent competencies. Whereas mines, minerals, oil, natural gas and water resources are defined as an exclusive competency of the federal government, power is a concurrent competency shared between the federal and state governments, though the delineation of powers is not clear cut. The federal government has a mandate to regulate power generation and transmission of the national grid. States also have a mandate to engage in power generation, while distribution of electricity seems to be confined to off-grid areas.

Some Nigerian states deduce a mandate for energy and climate out of the concurrent competencies for environment, social and economic development, arguing that energy is a vital and cross-cutting element for the achievement of the constitutional objectives in these three areas of concurrent competencies.

Some states such as Lagos and Rivers are already exploring various models to generate and distribute electricity and are now pushing for an enhancement in their powers so they can become less dependent on the national electricity stem and generate own revenues. With the privatisation of generation companies, states are actively seeking to acquire stakes in DISCOs as investments that offer both a long-term return and foster the prosperity of their inhabitants.

The power sector reform (cf. Chapter 3.4) has affected the distribution of roles between federal level, states and private sector with the states now able to acquire a stakeholder position in DISCOs. The local reach of the DISCOs coupled with the possibility of backing from the state can allow the state to shape the future expansion of the power distribution to closely match its aspirations.

Notwithstanding their constitutional mandate, the states have been engaging in electrification via grid extensions in the past and are likely to continue in the future. A close coordination with the newly established DISCOs will be crucial for a successful grid extension.

[16] Engr. Clement A. Oke, FNSE, Acting Chairman
Engr. Simeon Atakulu, Senior Performance Monitor, Generation
Engr. Joe Ajah, Senior Performance Monitor (Acting), Transmission
Engr. Abu Kadiri, Senior Performance Monitor (Acting), Distribution
Engr. Chike Madueke, Senior Performance Monitor, NIPP
Engr. Chidi Ike, Senior Performance Monitor, Market/Efficiency and Renewables
Mr. Azu Obiaya, Senior Performance Monitor, Regulatory and Transactions Monitoring
Mr. Ebipere Clark, Senior Performance Monitor, Program Management Unit
Mrs. Awele Okigbo, Senior Performance Monitor, Media and Communications Unit
Mr. David Tabai – Acting Secretary to the Board
Mallam Salisu Muhammad, Labor Relations Adviser

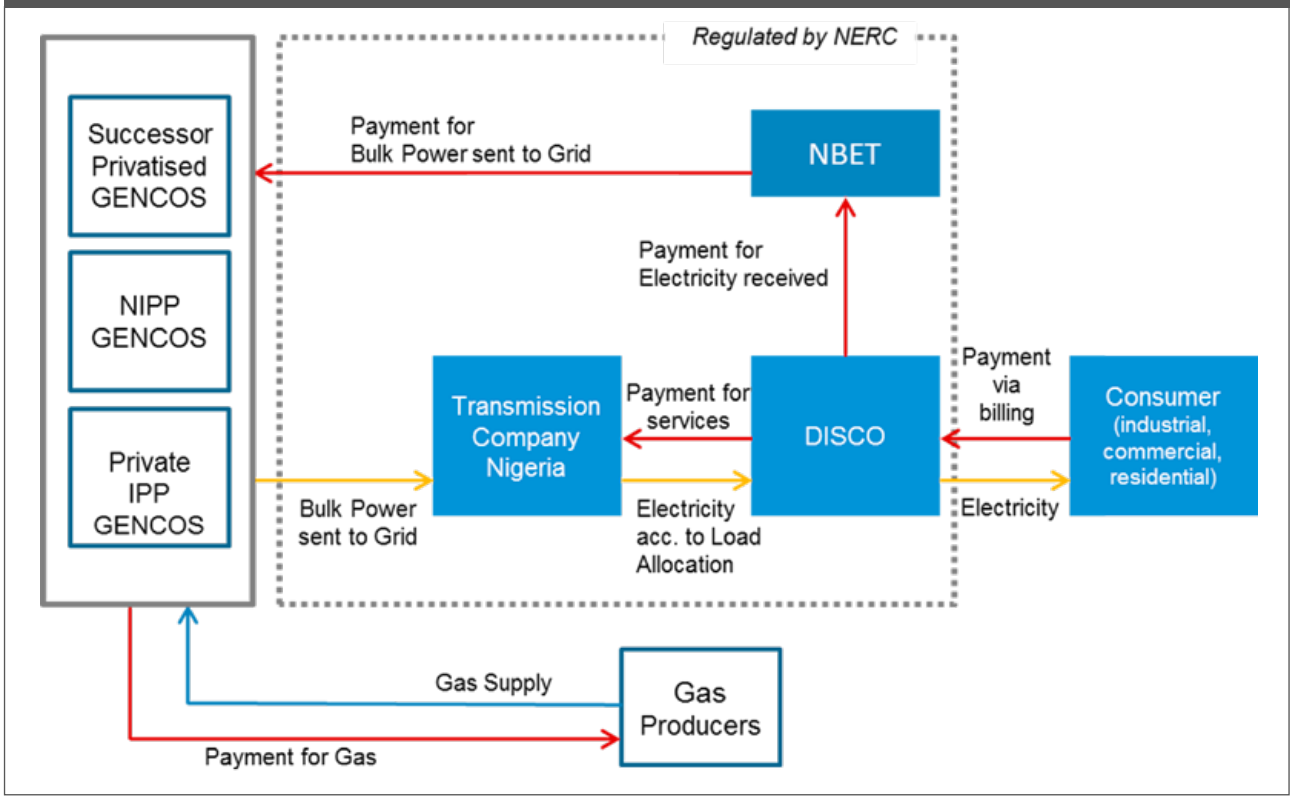
4.3 Market Players in Generation, Transmission and Distribution

The privatisation process (cf. Chapter 3) has introduced competition in the generation of electricity as a key aspect of electricity reform and decentralisation. A central feature of a decentralised electricity market is the wholesale electricity spot market or pool, where generating entities compete to supply energy through their supply prices or bids.

While transmission remains in the hands of government, generation and distribution are now in private hands following lengthy and in part fiercely contested bidding processes. The outcome of the bidding is clear and the process has moved forward, with government generating assets sold and new generating licenses having been awarded. The chart in Figure 4 – 2 describes the roles and responsibilities in the sector post-privatisation:

The electricity produced by various generation companies (GENCOs) is sent to the regional distribution companies via the Transmission Company of Nigeria. The DISCOs sell the electricity received to the industrial, commercial or residential consumers. Consumers in turn pay for the electricity drawn from the distribution network. These payments are forwarded by NBET to the generation companies. TCN is being paid for its services providing the network. The federal government implemented NBET as a bulk trader to compensate for any uncovered payments in the system through subsidies.

FIGURE 4 – 2:
STRUCTURE OF THE POWER SECTOR POST-PRIVATISATION



(Source: GOPA-International Energy Consultants GmbH)

Table 4 – 1 outlines the key players in the interim and transitional market which will be further described in subsequent sections. It will be readily apparent that the composition is still mixed:

In order to speed-up the deployment of new generation capacities, the Nigerian government embarked on the so called National Integrated Power Project (NIPP) programme essentially using government funds to build ten gas-fired power plants with the aim of eventually selling them off to private investors. This innovative approach, which however was beset with delays, is described more in detail in the box below.

So called Independent Power Producers are the third form of power utilities and are characterized by the fact that they were and are being developed from the beginning as privately owned greenfield power projects.

TABLE 4 – 1:
NIGERIAN POWER SECTOR – KEY INDUSTRY PARTICIPANTS

Key Industry Participant	Description
Power Holding Company of Nigeria (PHCN) Successor Generation Companies	• Nine companies for ten power plants. • Three hydropower plants and seven gas-fired plants. • Total installed capacity of 6,313 MW, of which 3,366 MW available. • Contracts for privatisation concluded
NIPP Generation Companies[33]	• Ten companies, each owning one gas-fired power plant • Total design capacity at ISO of 5,453 MW. • Five plants with an installed capacity of almost 2,000 MW fully or partially operational.
Independent Power Producers ("IPPs")	• Eight power plants with an installed capacity of 2,127 MW of which 1,320MW available. • Plants use either gas or oil as fuel.
PHCN Successor Distribution Companies	• Eleven distribution companies covering all 36 states and the Federal Capital Territory • Contracts for the privatisation of eleven companies executed
Transmission Company of Nigeria (TCN)	• State entity responsible for the transmission of electricity from power plants to distribution companies, eligible customers and for export • Acts as transmission services provider (TSP), system operator (SO) and market operator (MO) • Managed by Manitoba Hydro International of Canada under a three-year management contract • Separation into an Independent System Operator (ISO) and a Transmission Service Provider (TSP) ongoing
Nigerian Bulk Electricity Trading PLC (NBET)	• Government entity responsible for purchasing electricity from generation companies under long term power purchase agreements and selling it to distribution companies.
Nigeria Electricity Regulatory Commission (NERC)	• Independent agency established to regulate the power sector in Nigeria. • Responsible, inter alia, for the issuance and renewal of generation licenses and the determination of tariffs that sector participants may charge for their products and services.
Gas Aggregation Company of Nigeria (GACN)	• Established in 2010 to manage the implementation of the domestic gas supply obligation regulations. • Acts as the facilitator between suppliers and purchasers of natural gas.
Nigerian Gas Company Limited (NGC)	• One of the subsidiaries of Nigerian National Petroleum Corporation. • Responsible for the transportation of natural gas through its pipeline network.

* These companies are in the process of privatisation.

4.3.1 Generation Companies

Before privatisation, the government-owned generation companies comprised of three hydropower plants and seven thermal power generating stations [30]. As a preparation for the privatization, each entity was incorporated as a single-asset generating company under the rough of the Power Holding Company of Nigeria (PHCN). Because they were originally all government owned, after their privatisation these entities are called "PHCN Successor GENCOs".

See Table 4 – 1 above for information on the number of plants as well as their installed and available capacities for each of the three modalities.

The World Bank and the African Development Bank assist electricity investors with partial risk guarantees[17] with a total project volume of US$ 670 million. These instruments are offered through the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA) and the Multilateral Investment Guarantee Agency (MIGA)[18]. Partial risk guarantees from IDA and IBRD protect private lenders and/or investors against the risk of a government entity not fulfilling its end of a contract. Partial risk guarantees are suitable for the privatisation of infrastructure assets as in the Nigerian privatisation programme and those provided by MIGA protect investors and lenders from risks associated with changes in government policies.

The National Integrated Power Project (NIPP)

The National Integrated Power Project (NIPP) was conceived in 2004 as a major fast-track initiative to add significant new generation capacity to Nigeria's electricity supply industry using gas-based power plants. The generation projects were accompanied by supporting transmission, distribution and gas transport infrastructure projects and at the time financed from the Excess Crude Oil Fund.

The Niger Delta Power Holding Company Limited (NDPHC) serves as administering institution for the contracts, management and operation of the assets developed and built under the NIPP using private sector best practices. After suffering some challenges in year 2008 and 2009 due to financial allocations, a new structure was formulated under NDPHC to manage the construction projects and finally disinvest the projects to private investors.

Similar to the other public assets in the power sector, the ten key NIPP power plants were chosen to be privatised. This involved the following facilities: Gbarain (254 MW), Benin (508 MW), Omotosho (513 MW), Egbema (381 MW), Omoku (265 MW), Geregu (506 MW), Calabar (634 MW), Ogorode (508 MW), Alaoji (1,131 MW), and Olorunsogo (754 MW), with a combined generation capacity of 5,453 MW. Today, the NIPP power plants have an available generation capacity of 2,500 MW which however is severely restricted by the shortage of gas. Full capacity can be reached if challenges in the gas supply for remote plants are solved and if a steam cycle is installed in the plants where possible. Up to date government invested $8.26 billion in the NIPP programme and is currently negotiating contracts with the companies that emerged as preferred bidders in the competitive disinvestment process.

Prior to their sale, each power plant was structured as individual GENCO. NDPHC required further that the systems would have to be fully commissioned beforehand with all contractual structures in place. This set-up should reduce the exposure of investors to technical risks from the construction and commissioning phase. The plants have been or are being constructed by international engineering, procurement and construction (EPC) contractors using proven technology and established original equipment manufacturers (OEMs). On the commercial side, the configuration follows the IPP modality recently developed in the market. The generation companies will sell the electricity under a 20-year power purchase agreement to NBET. The corresponding tariff will reflect the rates set forth in the most recent multi-year tariff order. Each GENCO will procure its feedstock (natural gas supplies) under long-term gas supply agreements with the Gas Aggregation Company of Nigeria (GACN). GACN was formed on January 5, 2010 and is owned by the upstream joint ventures formed between NNPC and international oil companies operating in Nigeria.

According to NDPHC the second phase of the National Integrated Power Projects (NIPPs), which will concentrate on building hydro power generation plants, will add 4000 MW of electricity to Nigeria's generation profile. This will include the construction of the 1,030 MW Mambilla hydro power project and 16 other identified medium and small hydro power projects. Furthermore, the second phase of the NIPPs will also include the construction of critical transmission projects that will enable the country wheel over 20,000 MW of electricity generated from existing and new power stations to distribution networks across the country.

[17] The development objective of the Power Sector Guarantees Project for Nigeria is to increase the supply of electricity received by Nigerian consumers. The project supports one component, partial risk guarantee (PRG) series with three sub-components based on the type of transactions supported: (i) greenfield independent power producers (IPP) transactions will include the option of both credit enhancement for Nigerian bulk electricity trading (NBET) and private debt mobilisation support, that is: (a) the NBET credit enhancement guarantee, with or without letter of credit; (b) the commercial debt mobilisation guarantee; or (c) a combination of both forms of guarantees; (ii) privatisation of generation companies (GENCOs) will include both gas-fired as well as hydropower companies; (iii) under privatisation of distribution companies (DISCOs), the ability of the DISCOs to successfully turn around dismal customer service levels and improve revenues flows to finance investments upstream in the value chain will make or break the power sector reform efforts. Out of the 11 DISCOs being privatised, four have been identified as advanced stage candidates: Abuja DISCO, Benin DISCO, Eko DISCO, and Ikeja DISCO. (cf. World Bank Project ID: P120207)

[18] IBRD, IDA and MIGA form part of the World Bank Group.

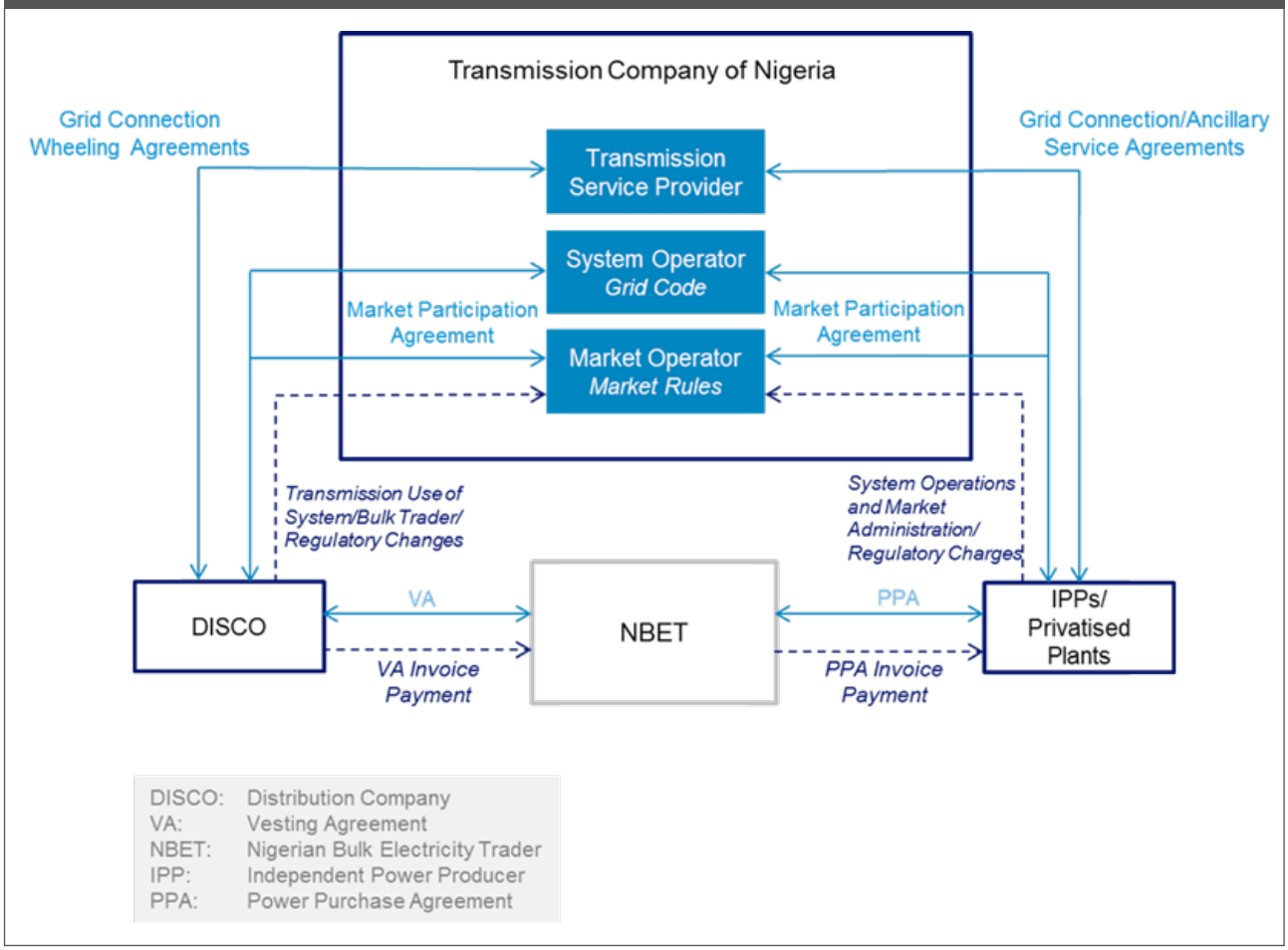
4.3.2 Transmission Company of Nigeria

The neutral role of grid owner is played by the TCN, which holds PHCN's grid assets and manages it on behalf of the government. Management has been outsourced to a private Canadian company. The operation of TCN includes the key three functions of market operator (MO), system operator (SO) and transmission service provider (TSP). Governmental plans are to separate the TSP entity from the MO and SO allowing it to become a privatised commercial company. Figure 4 – 3 shows the responsibilities more in detail.

4.3.3 Distribution Companies

For the market to operate freely, the generating companies must be able to sell their electricity to distribution companies who then sell it to the end consumers. NERC sets the tariffs that these off-takers must pay the GENCOs just as it sets the remuneration the DISCOs shall receive from consumers in what has to date been a highly subsidised system in which many electricity bills were never paid. Nevertheless, planning has gone ahead and the 11 licenses for the DISCOs awarded. In many cases, the respective states have shares in the companies (cf. Chapter 3.9).

FIGURE 4 – 3:
THE TRANSMISSION COMPANY OF NIGERIA



(Source: GOPA-International Energy Consultants GmbH)

4.4 Other Non-Governmental Stakeholders

Other stakeholders are active in the fields of renewable energy, energy efficiency and rural electrification. Some organisations are mentioned below in a non-exhaustive list.

4.4.1 Council for Renewable Energy in Nigeria (CREN)

The Council for Renewable Energy in Nigeria (CREN) is a non-profit multi-stakeholder association which promotes the use of renewable energy technology in Nigeria and the reduction of greenhouse gas emissions. CREN acts as a forum where stakeholders such as industry, politics, academics and financial institutions discuss the development of renewable energies and their integration in a sustainable energy strategy for Nigeria. CREN addresses issues of awareness, availability, cost and appropriate implementation of renewable energies in order to support a reliable, economically viable energy system.

4.4.2 Manufacturers Association of Nigeria (MAN)

Nearly 2000 Nigerian companies of the manufacturing, construction and service sectors are members of the Manufacturers Association of Nigeria (MAN). The association represents their interests vis-à-vis politicians, other sectors of the economy and society at large. MAN also formulates policy suggestions seeking to ensure an efficient and profitable environment for manufacturers. (c.f. Chapter 7.4.2.) [22]

4.4.3 Nigerian Society for Engineers (NSE)

The Nigerian Society for Engineers (NSE) is an organisation for the engineering profession in Nigeria. The society represents engineers and their matters in politics, society and industry. For example it seeks to promote and maintain a high standard of formal engineering education and to enhance engineering research. In this context the NSE arranges study tours, organises conferences and publishes books and journals.

4.4.4 Green Building Council of Nigeria (GBCN)

The Green Building Council of Nigeria (GBCN) is involved in the development of a green building rating system. This rating system shall unify competing concerns in order to provide a single metric to assess the relative sustainability of a building. [71]

4.4.5 Nigerian Institute of Architects (NIA)

NIA is a member organisation of professional architects, with the objective of promoting the practice of the profession of architecture in Nigeria. [60]

4.4.6 Nigerian Institute of Building (NIOB)

NIOB is a professional institute in Nigeria for persons engaged in a managerial, technical or administrative capacity in the development, construction and maintenance of buildings, including those who are engaged in academic research and teaching. [41]

The energy policy of Nigeria mainly encompasses the development and regulation of the petroleum and electricity industry. Both sectors were characterised by large government agencies that were responsible for a large part of the activities but have undergone significant changes in recent years. These sector and market modifications are mainly driven by a constant move towards privatisation and liberalisation.

First a general overview of the two relevant energy markets (petroleum and electricity) is provided followed by a short excursus on Nigeria's climate policy. In a second step, key policy and regulatory documents are reviewed more in detail in a chronological order.

5.1 Fuel Market Policy and Strategy

One of the pillars of the Jonathan administration's Transformation Agenda is the progressive deregulation of the petroleum industry. The partial removal of the fuel subsidy on Premium Motor Spirit (PMS) by the federal government in January 2012 was intended to conserve and maximise Nigeria's oil wealth. The government set up a fund into which the revenue otherwise dedicated to the subsidy would be funnelled, the Subsidy Reinvestment and Empowerment Programme (SURE-P) [57]. It is mandated with using the subsidy savings to invest in infrastructural projects and social empowerment initiatives.

At the same time, by initiating a complete elimination of the fuel subsidy, the administration seeks to promote the establishment of new private-sector refining capacities in-country. Applications have been filed for licences for this purpose, above all to build a large refinery in the Lekki Free Trade Zone, Lagos. The foundation of new refineries would serve to ease the regular market bottlenecks experienced in petroleum products. This goes hand in hand with some of the objectives set out in the "Draft Petroleum Industry Bill". [PIB; 2012] The PIB stipulates the management and allocation of petroleum resources shall be in accordance with the principles of good governance, transparency, and promote sustainable development and economic value added. [PIB; 2012] The approval of the Bill by Parliament has been pending since several years. In the course of this period, there has been a tendency among International Oil Companies (IOC) to sell off onshore oil blocks to indigenous companies and to focus operations offshore.

The PIB defines all aspects governing the exploitation, administration and organisation of the petroleum sector in Nigeria. It will supersede all previous petroleum-related laws such as the Petroleum Profits Tax Act or the Deep Offshore and Inland Basin Production Sharing Act. After establishing the objectives, the Act tackles all major areas of the sector which are: the management of the petroleum industry by institutions and definitions for upstream petroleum, downstream licensing, downstream petroleum, indigenous companies, health as well as safety and environment, taxation in the petroleum industry and stipulations for the organisation of the transition towards this new law.

The major items and stipulations can be summarised as follows:

- The bidding processes for the award of mining licences is monitored by the Nigeria Extractive Industries Transparency Initiative (NEITI)
- The re-structuring of the petroleum industry administration, with the
  - Minister of Petroleum Resources being responsible for the formulation and monitoring of the petroleum policy; the negotiating and implementing of international petroleum treaties and agreements with other countries or agencies on behalf of the government; and advising the President on appointments of chief executives of all companies and agencies established pursuant to the Act.
  - Petroleum Technical Bureau ('the Bureau') tasked to provide technical professional support to the Minster on matters relating to the petroleum ministry.
- The requirement for the administration to conduct a

public inquiry in the case of planning changes to the regulation.

- Reorganisation of the petroleum equalisation fund and its administration
- The transfer of the NNPC into separated, unbundled companies catering for the sub-sectors and their successive privatisation:
  - The National Petroleum Assets Management Corporation
  - The National Oil Company
  - The National Gas Company

5.2 Electricity Market Policy and Strategy

5.2.1 Introduction

The policies governing the electricity market and corresponding regulations have undergone significant changes in the last two decades. The main focus has been the drive from a monolithic, vertically-integrated organisation under the roof of the state-owned utility National Electric Power Authority (NEPA) toward a multi-actor landscape in a liberalised and privatised market. In the late 1990's the population and the economy both grew rapidly while NEPA failed to keep pace with this demand increase by adding more generation capacity and expanding the electricity system. This development led into an energy supply crisis in 2001. In reaction to the situation, in 2001 the Federal Executive Council (FEC) issued the National Electric Power Policy (NEPP), aimed at fundamental changes of ownership, control and regulation of the power sector. This and subsequent policies as well as legislative changes focused on privatisation and liberalisation of the electricity sector.

This fundamental change was kicked off under the assumption that the creation of an investor-friendly environment with low participation of governmental institutions and strong central regulation would help the country to overcome the previously poor service, low availability and high frequencies of outages in the system. The policy was the basis for the formulation of the Electric Power Sector Reform Act (2005), which constitutes the legal foundation for the process. The transfer of NEPA to PHCN and the subsequent splitting up of its assets into 18 separate successor companies responsible for generation, transmission and distribution as well as the establishment of the regulatory authority NERC are the central pillars of the reform. For a detailed description of the privatisation process see also Chapter 3.

On the commercial side, the Transitional Electricity Market (TEM) was declared by NERC and commenced with the beginning of February 2015. Power trading arrangements are from now on bound by contracts. This is the result of the first major step in the reform process set in motion in 2010, when President Goodluck Jonathan inaugurated the Roadmap for Power Sector Reform based on the 2005 EPSRA, aiming at the successful delivery of the reform milestones embedded in the roadmap. The roadmap contained two core objectives at its launch:

Firstly, to transition the Nigerian power sector into a private-sector led market ("The Reform Objective") by instituting transparent and responsible management, limiting political interference, eliminating government involvement in utility management, and encouraging private investment in generation (privatisation of PHCN and NDPHC assets). At the same time, the idea was to create a level playing field for all investors. Secondly, the reform process was intended to support and improve service delivery levels during this transition to the Nigerian public ("The Service Delivery Objective").

The overall intention behind the reform process was twofold: to release government funds otherwise tied down in generating capacity and to avoid having to commit substantial public-sector revenues to providing additional capacity. In this way, government would be able to focus more strongly on education, health and other infrastructure projects. At the same time, the hope was also that the reform would encourage fast expansion of the power

sector by ensuring it was market-driven and that the shortfall in generating capacity and the attendant potential demand would provide attractive opportunities for private investments.

Coincidentally, the Presidential Action Committee on Power (PACP) was set up to fast-track the reform process by enabling regular, fast round-table and cross-ministerial decision-making.

Finally, the process of the continuous changes over the last two decades has been instrumental to the achievement of the following key reform milestones include:

- New Tariff (MYTO II) instituted – June 2012
- Appointment of Manitoba Hydro International as TCN management contractor – June 2012
- Winning Bidders for GENCOs and DISCOS announced – November 2012
- Payment of 25% of the equity sale value by purchasers – February 2013
- TCN Board Inauguration - April 2013
- Eurobond Commitment for Capitalization Support of NBET and Project Financing of TCN – May 2013
- MYTO II Minor Tariff Review – June 2013
- Outstanding 75% payment of power assets by bidders – August 2013
- Handover of PHCN DISCOs and GENCOs to new owners – November 2013
- 15% cash payments by the preferred bidders for the assets in early 2014.
- Bidding process for NIPP GENCOs completed in spring 2014.
- MYTO 2.1: minor tariff review and review of ATC&C losses – January 2015
- Commencement of the Transitional Electricity Market ("TEM") – February 2015
- Amended MYTO 2.1: adjustment of ATC&C losses – April 2015

5.2.2 Major Programmes and Initiatives, Policy Mix

All policy stems from the Electric Power Sector Reform Act of 2005. In line with its goals, a National Energy Master Plan (NEMP) was formulated with a short-term horizon of 18 months, which culminated in an Electricity Master Plan in 2008. A roadmap for the reform of the sector was drawn up and approved in 2010, on the basis of which MYTO II was issued in 2012, while the grid and distribution codes were likewise set. In 2015 MYTO 2.1 was put into effect, delivering a revalidation of ATC&C losses as well as a minor tariff review. The TEM commenced with effect from 1st of February 2015. The TEM is characterised by "contract based arrangements for electricity trading and the introduction of competition for entry into the Market" [74]. This means that all electrical trading arrangements are bound by contracts. Hence Power Purchase Agreements (PPA), Vesting Contracts and Gas Supply Agreements, executed during the privatisation process, are effective now [75] (see Chapter 3 for further details).

This overall process occurred simultaneously to the preparation of the Gas Master Plan. During this period, the Renewable Electricity Action Programme, launched in 2006, was shored up first, in 2010, by the National Policy and Guidelines on Renewable Energy, and then in 2012 by the Renewable Energy Master Plan. The plan still has to be enacted but is consistent with the MYTO 2.1 tariff provisions for renewables. A National Renewable Energy and Energy Efficiency Policy (NREEEP) was developed in 2013 – 14 by the FMP and approved by the Federal Executive Council in May 2015. The draft Energy Efficiency Bill still awaits enactment. The same situation prevails as regards rural electrification, where despite having released an initial Rural Electrification Strategy and Implementation Plan in 2006 and this having progressed in various forms to culminate in the Rural Electrification Strategy and Plan, no legislation other than the general Power Sector Reform Act has been forthcoming. This means inves-

tors face a conundrum: The policy intention of buttressing renewables and rural electrification is clear, but as yet there is no firm regulatory regime governing them. It remains to be seen whether the rather high-level NREEEP is able to fill this void.

Other than the Renewable Electricity Action Programme and the industry incentives for Renewable Energy (e.g. MYTO 2.1), to date no mainline national programmes are in place that complement the policy mix. These two programmes are intended to support policymaking, but without clearly enacted laws or approved master plans it is hard to see what impact they can have. The main bodies of legislation (policy mix) and the various programmes put in place to support the use of renewable energy sources, rural electrification and energy efficiency measures are the subject of the Chapters 6, 7 and 8, respectively.

5.3 Climate Change Policy and Strategy

On September 12, 2012, the Federal Executive Council (FEC) approved a National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN) as a national document for implementing climate change activities in Nigeria [3]. The policy is in line with the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

A National Advocacy Campaign on Adaptation in Nigeria (NACAN) was set up to review the national policy on climate change strategy and the NASPA-CCN in detail every five years. The first review of the NASPA-CCN in 2015 will allow Nigeria to incorporate experiences into the 2015 review of Nigeria's efforts to achieve the MDGs. Looking further to the future, the ten-year time frame for the second NASPA-CCN review cycle is in line with the timeframe of Nigeria Vision 20:2020.

The strategy entails the vision of creating a country in which climate change adaptation is an integrated component of sustainable development, reducing the vulnerability and enhancing the resilience and adaptive capacity of all economic sectors and of all people – particularly women, children, and men who have little resources – to the adverse impacts of climate change, while also capturing the opportunities that arise as a result of climate change.

Its goal is to take action for adapting to climate change by reducing vulnerability to climate change impacts and increasing the resilience and sustainable wellbeing of all Nigerians; and to reduce or minimise risks by improving adaptive capacity, leveraging new opportunities, and facilitating collaboration inside Nigeria and with the global community. The principal aspects under this context are desertification, loss of forest cover, carbon dioxide emissions, water scarcity or other changes in the environment that directly affect the livelihood of people.

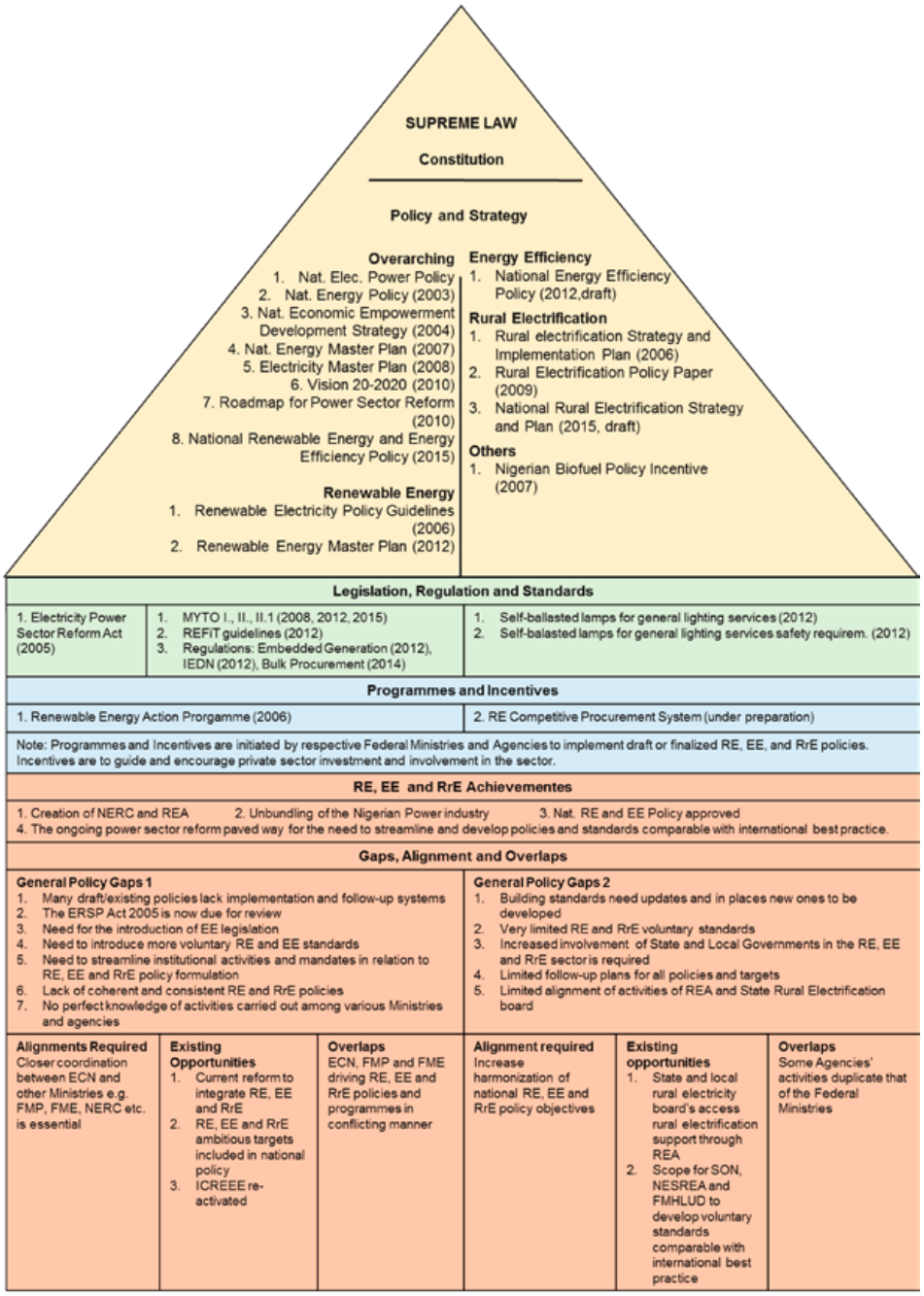
The climate change policy regards energy resources and connected infrastructure as vulnerable to the impacts of climate change. Since the supply of energy is a service of public interest, any negative change of its availability and quality impedes the development of other sectors and citizens. So-called sustainable energy and also renewable energy is regarded as a one of the measures to reduce risks as regards energy supplies and the pressure on the environment. The mitigation effect such technologies could have due to their reduced or even non-existent emissions on the climate changes themselves are not considered as a reason for their promotion.

The FMENV's dedicated climate change unit has a key role to play in the implementation process and has since the inception of the policy and strategy been devising the relevant programmes [52]. The programmes of the ministry are further detailed in Chapter 6.1.2.

5.4 Milestones in National Energy Policy and Laws

This Chapter contains a summary of each of the major strategies, policies, acts, regulations, norms and standards with a focus on the power sector. The relevant legislative and regulatory documents are summarised in chronological order. An overview on the policies and regulations is also depicted in Figure 5 – 1.

FIGURE 5 – 1:
OVERVIEW OF PRINCIPAL POLICIES AND LAWS



Source: [GIZ; Oct 2013]

5.4.1 National Electric Power Policy (NEPP), 2001

This policy statement was the initial step towards reforming the electricity sector. It is the result of the consultations of the Electrical Power Implementation Committee (EPIC), the central body tasked to elaborate, coordinate and monitor all activities relating to the reform, restructuring and privatisation of the power sector [Dayo; 2008]. It defined the three principal phases for achieving the reform goal of a reliable and sufficient energy system. The first step aimed at the privatisation of the vertically-integrated parastatal company NEPA and the introduction of IPPs as well as private emergency power producers. The second step focused on increasing the competition between market participants, reduction of subsidies (i.e. payment of full fuel prices) and sale of excess power to DISCOs. During the last phase the market and competition would even be more intensified by full cost pricing of supply, liberalised selection of supplier beyond the local DISCOs by larger customers and full competitive market trading.

The provisions were – to a large extent – incorporated into the Electric Power Sector Reform (EPSR) Act of 2005 [FMPS; 2006]. This marked the milestone for the implementation of the reform policy.

5.4.2 National Energy Policy (NEP), 2003

This document was designed to stand as the first overall framework for the development of the sector and its effective contribution to the country's economy. It covers the development, exploitation and supply of all energy resources (petroleum and electricity), their utilisation by different sectors and other related topics such as the environment, energy efficiency and energy financing as well as energy policy implementation. [ECN; Apr 2003]

After a short introduction and overview, it looks briefly at the various aspects, describes the policy goals and lists individual objectives for the policy – which could also be understood as indicators to measure the achievement of the policy goals. The policy includes renewable energy sources, rural electrification and expansion of electrification as well as energy efficiency at many points of the sector-wide framework. In this context, it elaborates in a very straight-forward manner on the policy goals, strategies and goals for the respective energy sources including renewable energy and rural electrification. It therefore provides the basis for subsequent changes in the sector such as the establishment of the Rural Electrification Fund later incorporated under the Rural Electrification Agency as well as constituting a blueprint for all subsequent policies on the promotion of renewable energy.

Although parts of the policy required an update and new developments in the sector were covered in subsequent policy papers or acts, the policy still remains in force as the guiding principle for the direction of sector reforms. In 2013, NEP was reviewed to reflect recent developments Energy sector with emphasis on Renewable Energy and Energy Efficiency, amongst others [48]

Renewable energy: The NEP 2003 recognises that the level of energy utilisation in an economy coupled with efficiency of the conversion of energy resources is vital for the development of the economy. Thus, it made provision for all forms of energy including renewable energy sources and how they can be effectively utilised. However, no concrete quantitative targets have been set.

Energy efficiency and conservation: NEP 2003 pointed out that energy utilisation of the country is far from efficient and called for the promotion of energy conservation at all levels of exploitation of the nation's energy resources by adopting energy efficient methods in energy utilisation. However, no concrete quantitative targets have been set.

Rural electrification: NEP 2003 recommends the promotion of off-grid and standalone systems in order to supply electricity to remote areas of the country.

5.4.3 National Economic Empowerment and Development Strategy (NEEDS), 2004

The strategy issued in 2004 by the National Planning Commission under President Obasanjo was intended as the response to the development challenges of Nigeria. It was intended to guide combating the grossly underestimated extent of social, political, and economic decay in the country since 1999, to serve as an overarching statement for the following years (2003-2007) to consolidate the achievements of the previous legislative period and formulate the basis for further sustainable poverty reduction, employment generation, wealth creation, and value reorientation.

As regards infrastructure, the policy promotes the privatisation of infrastructure which is regarded as key instrument for achieving improved service delivery. The government would still remain important for funding projects with high investment requirements or low attractiveness for the private investors (i.e. rural areas). The document further suggests increasing the share of renewable energy in the total energy mix. It again stresses the need for the renewable energy agency and its equipment with respective funds through the Electric Power Sector Act (i.e. the National Power Sector Reform Act). It therefore represents one more step towards inclusion of the role of renewable energy in the power sector and emphasises the importance of continued efforts for rural electrification.

5.4.4 National Power Sector Reform Act (EPSRA), 2005

In 2005, the Nigerian power sector was liberalised by the Electric Power Sector Reform Act (EPSRA) [EPSRA; 2005]. This Act, which is a consequence of the National Electric Power Policy adopted in 2001, provides a new legal and regulatory framework for the sector. The fundamental change it entailed was the privatisation of the government-owned electricity company and the process towards a completely liberalised market. It makes provisions for the vertical and horizontal unbundling of the electricity company into separate and competitive entities; development of a competitive electricity markets; setting out of a legal and regulatory framework for the sector; a framework for rural electrification; a framework for the enforcement of consumer rights and obligations: establishment of performance standards. It resulted in the transfer of the previously public power company, NEPA, into a (temporary) Holding Company, the Power Holding Company of Nigeria (PHCN) - called "Successor Company" in the legal text. The reform act in general kicked off the horizontal and vertical unbundling and privatisation of the NEPA by the following processes:

1. Transfer of NEPA assets to the holding company PHCN and its successive restructuring by privatisation and transfer into 18 different generation, distribution and transmission companies;
2. Development of a competitive electricity market by creation and operation of a wholesale electricity market in Nigeria;
3. Foundation of the Nigerian Electricity Regulatory Commission (NERC) as national regulatory body to oversee the market and administer licences;
4. Requirements for licensing, its conditions and regulation of the generation, transmission, system operation and distribution, as well as supply of generated electricity;
5. Introduction of tariffs and corresponding calculation methodologies to be elaborated and adopted by NERC;
6. Implementation of consumer rights and consumer protection including the Power Consumer Assistance Fund to subsidise the tariff for less-privileged consumers;
7. Use guiding standards and codes as guidelines and requirements for activities in the sector;
8. Establishing a Rural Electrification Agency to expand access to electricity to the rural areas and the financing of its activities.

The reforms under this Act were to be done in consecutive phases. The implementation of the reform started

well, but suffered delays. For instance, even though licences were granted for the private sector to build independent power plants, the very low tariffs made it impossible to fully recoup the costs of doing business and thus prevented investments in new generation capacity and necessary upgrades to the transmission and distribution networks.

In short, the law restructured the whole energy landscape of the country along the value chain with different players for generation, transmission, distribution and commercialisation. The intention was to increase competition significantly by establishing a Wholesale Electricity Market (WEM) and promoting the participation of private companies in the generation as Independent Power Producers (IPP).

The law can be considered as the most important legislation in the sector and resulted in a broad range of changes within recent years since it lays a foundation for the new institutions, restructuring older public enterprises, and sets the future direction of the power market.

In terms of renewable energy, the Act encouraged the promotion of electricity generated from all sources of energy including renewable energy by mandating NERC to create a level playing field in the Nigerian electricity market.

The Act also mandates NERC to ensure that all electricity generated is fed into the grid and is efficiently sourced and delivered to the consumers. The Act recommended the creation of the REA and stipulates under section 88(9) that information presented to the President by the Minister of Power and Steel should include expansion of the main grid, development of isolated and mini-grid systems, and renewable energy power generation. The REA was also mandated to provide a strategy plan for expanding access to electricity including the use of renewable energy.

5.4.5 Renewable Electricity Policy Guidelines (REPG), 2006

The document issued by the Federal Ministry of Power and Steel stipulated that the federal government would expand the market for renewable electricity to at least 5% of total electricity generation and a minimum of 5 TWh of electric power production by 2016.

The Policy Guidelines on Renewable Electricity (herein referred to as the Policy Guidelines) is the federal government's overarching policy on all electricity derived from renewable energy sources. The Policy Guidelines sets out the federal government's vision, policies and objectives for promoting renewable energy in the power sector.

In the document, renewable energy is clearly regarded as means to extend electricity services to those not yet connected to supply sources (e.g. new settlements in urban areas) and to run electrification campaigns in rural areas. These aspects make a clear distinction between renewable energy and other energy generation technologies – with the exception of diesel based generation. As a final goal, renewable energy shall in the mid-term be integrated into the energy mix of the national grid. The policy recognises the advantages renewable energy can bring to the system such as adding additional generation to the constrained system, enhancing the stability by mitigating local disruptions in supply and reduction of emission.

The document gives a very brief overview of the electricity sector situation, recaps the role and situation of renewable energy against the background of other policies and the legal framework, reviews the existing and preceding policies including their targets, formulates RE policy objectives, and sets the following policy goals along with respective strategies:

1. Expansion of the market for renewable electricity to at least five percent of total electricity generating capacity and a minimum of 5 TWh of electric power production;

2. Establishment of stable and long-term favourable pricing mechanisms and ensuring of unhindered access to the grid with guaranteed purchase and transmission of all electricity produced by renewable electricity producers and obliging the grid operators to upgrade the system accordingly;
3. Construction of independent renewable electricity systems in areas not covered by the electricity grid;
4. Development of innovative, cost-effective and practical measures to accelerate access to electricity services in rural areas through renewable sources;
5. Setting up of a Renewable Electricity Trust Fund to be governed by the Rural Electrification Fund.
6. Creation of a multi-stakeholder partnership for the delivery of renewable electricity to meet national development goals;
7. Broadening international cooperation in expanding the role of renewable electricity for meeting national development goals and contributing to global efforts in addressing climate change.

Further to these goals, the document looks at the energy reserves and renewable energy potentials, the global capacities and technologies together with their costs trends.

REPG recognised that Nigeria's electricity needs cannot be met through conventional energy sources alone, especially in rural areas where grid expansion and access is very limited in the short-medium term. Off-grid renewable energy electricity operations are vital to meeting the federal government's policy on the electric power sector and expanding access to rural areas. Rural electricity options offered via renewable energy sources include mini-grid concession and standalone systems. In financing renewable electricity, REPG provides that rural electrification trust funds (RETF) should be set up to promote, support and provide renewable electricity through private and public sector participation. [FMPS; 2006]

5.4.6 Renewable Electricity Action Programme (REAP), 2006

The Renewable Electricity Action Programme (corresponding to the REPG) was issued by the Federal Ministry of Power and Steel in 2006.

The Renewable Electricity Action Programme (REAP) was produced the same year and sets out a roadmap for implementing this policy. The core focus of the document is on utilising all forms of renewable energy sources for electricity generation and highlights potential gaps, technical assessments and financial implications. The REAP gives an overview on the Renewable Energy potentials, technologies and markets and then elaborates on the development targets per technology and application, strategies for their achievement. It also outlines financing procedures via the Renewable Electricity Fund (REF) and other sources, looks into roles of government bodies and concludes with a risk assessment as well as structures for monitoring and evaluation.

The study is relevant for mid-term on-grid renewable energy but more interesting for the rural energy supply since this was the principal application area of renewable energy at the time of writing.

However, this programme seems to be abandoned with the restructuring of the Ministry of Power and Steel to the new Ministry of Power.

5.4.7 National Biofuel Policy and Incentives (2007)

This document was issued at the peak of the global biofuel promotion trend and formulates a biofuel support programme aiming at integrating the agricultural sector of the economy with the downstream petroleum sector. The authors assumed that biofuels would impact on the quality of petroleum products from a market perspective where the use of fossil-based fuels have been increasingly

regarded as an environmental concern and demand for more environmentally friendly fuel has risen worldwide.

As regards biofuels, the document refers to ethanol and bio-diesel or other fuels made from biomass and primarily used for automotive, thermal and power generation, according to quality specifications stipulated by the national norms and standards. Under biomass, the policy-makers understand agriculturally produced raw materials which are available on a renewable or recurring basis, including trees, crops, plant fibre, cellulose based materials, industrial wastes, and the biodegradable component of municipal solid waste.

The objective of the policy was the development and promotion of a national fuel ethanol industry utilising agricultural products in order to improve the export properties of automotive fossil-based fuels produced in Nigeria. The policy sets out to link the agricultural and energy sectors with the underlying aim of stimulating development in the agricultural sector. The following benefits were intended to be achieved: additional tax revenue by economic activities of this industry, job creation, increased economic development and empowerment of rural communities, agricultural benefits via improved farming techniques, increased agricultural research, and increased crop demand resulting from activities in the industry, energy benefits from co-generation benefits, environmental benefits with the reduction of exhaust emissions and ozone pollution as well as reduction in particulate emission and replacement of toxic octane enhancers in gasoline.

The most distinct targets of the policy include a contribution of all biofuels companies with 0.25% of their revenue towards funding research into feedstock production, local technology development and improved farming practice. An import duty waiver for biofuels granted by for 10 years and exemption from taxation, withholding tax and capital gains tax imposed in respect of interest on foreign loans, dividends, services rendered from outside Nigeria to biofuel companies by foreigners will be required.

With off-take guarantee by NNPC for biofuels as buyer of last resort, the Biofuel Production programme could aspires to achieve 100% domestic production of biofuels consumed in the country by 2020.

The objective was to implement the policy in two phases: the market-seeding phase and the operational biofuel production programme. During implementation, several components were to be considered for a successful attainment of the objective: setting up a Biofuels Energy Commission, establishment of a Biofuels Research Agency and further measures such as granting the industry and its products pioneer status, support of importation, execution of blending by NNPC, installation of industry incentives, instantiation of off-take guarantees and integrating government ministries and state agencies in the sector development activities.

Although the policy seems to be in force, no information is available as to the extent to which it has been implemented and whether adjustments have been made to it in light of experiences gained with the first steps and after feedback from players in the agricultural and petroleum subsectors. The major player, NNPC performed feasibility studies on ethanol production as well as cassava and palm-oil-based products but only mentions a few projects and initiatives on its website. It can be concluded that the topic gained most interest during the peak years 2009-2012 of the global move towards biofuels but lost momentum after this source was largely criticised for its conflicting use of foodstuff and agricultural land for the cultivation thereof.

5.4.8 Roadmap for Power Sector Reform, 2010 and 2013 (Update)

In December 2012, the Presidential Task Force on Power (PTFP) presented its Roadmap for Power Sector Reform –

Revision 1 (August 30, 2013) [PTFP; 2013] based on the Roadmap for Power Sector Reform 2010 [PTFP; 2010] including reviewed and fine-tuned plans and strategies to finalise the drive to complete the power sector reform and setting the nation on a steady course to produce clean and efficient electricity in the country at competitive rates. The Roadmap does not, in principle, introduce new policies but rather sets strategies to accelerated actions for achieving the objectives of the National Energy Policy (2003) as enshrined in the Electric Power Sector Reform Act (EPSRA) of 2005. It aims at providing an update on the status of the reform as well as pointing out critical issues and challenges which should be addressed in the period of 2013 – 2014.

After describing memoranda from key market institutions and assessing their respective performance with regards to the implementation of the reform, the roadmap takes a closer look at the key aspects of the sector and the development including fuel-to-power (i.e. fossil fuel supply), generation, transmission and distribution as well as the National Integrated Power Projects. It develops a set of recommendations and proposals for the continued development and reviews the media coverage of the reform.

The principle issues and activities required for the full implementation of the reform agenda are:

- Development of an optimal transmission capacity expansion plan and funding strategy to provide a reliable highway for wheeling generated power;
- Acceleration of the management and operational efficiency levels of the Transmission Company of Nigeria (TCN);
- Improvement of collection efficiency and returns to the market during the pre-Transitional Electricity Market (TEM) declaration stage;
- Commencement and conclusion of all labour negotiations, settlement of liabilities, rationalisation and eventual winding down of the Power Holding Company of Nigeria (PHCN).
- Continuation of the clear and firm political will to resist efforts that could undermine privatisation and the reform.
- Firm commitment to deliver the gas development and transportation infrastructure projects earmarked for gas-to-power alignment.
- Prevention of frequent acts of vandalism to pipelines such as the Trans-Forcados and Trans-Niger crude oil lines, and the Escravos Lagos Pipeline Systems (ELPS) gas pipelines.
- Clarity on the interim operation and maintenance of the National Integrated Power Projects (NIPP) generation assets;
- Firm commitment from NIPP to deliver its critical transmission projects scheduled for 2013 as well as the Omoku, Gbarain and Alaoji power plants to come on stream without further delay;
- Meeting of the conditions precedent to the declaration of TEM, before the handing over the successor companies to the new owners.
- Positioning a well-capitalised Nigerian Electricity Liability Management Company (NELMCO) to address post hand-over fall outs from creditors.
- Securing a minimum, transitional service-delivery level through project and process optimisation.

The Roadmap is very limited in terms of renewable energy, energy efficiency and rural electrification. The core focus of the Roadmap was on other forms of energy delivery systems. In summary, it is the guiding high-level planning document of the administration containing a review of the reform process until 2010 and a listing of action for the next planning period complied based on the check of the performance, development and progress.

5.4.9 Vision 20:2020, 2010

The Vision 20:2020 as released at the end of 2010 outlines the path for the global and national vision to position the country among the leading 20 economies of the world in 2020 and aims at a holistic transformation of the economy. The vision programme identifies the barri-

ers to the country's development (e.g. unreliable power supply, poor and decaying infrastructure, high dependence on the oil sector) and names the directions for achieving the target using a strategy of three main pillars building one on to each other. These central parts aim at guaranteeing the foundations of productivity and wellbeing, optimising key factors of economic growth and at promoting a sustainable economic development. [24]

Energy provision is regarded as a key component of all three pillars. Its development is intended to be led by the private sector in a liberalised market. The role of government and state agencies shall then be limited to providing the legal and regulatory environment. Overall, an increase of the installed capacity to 35,000 MW by 2020 is planned for. The vision does not detail what study or factor was used to determine this target nor does it state whether any efforts are planned to de-couple economic development (growth) from an increase in energy consumption, e.g. by undertaking major efforts to increase the overall energy efficiency.

The country's dependence on the exploration of petroleum is seen as a major weak spot in the economy and the document establishes the need to diversify the national income away from that source. This concern is based on major market and demand-side trends and dampens the production outlook. This includes the assumption that the world market for petroleum does not evidence the same upward trend as in previous years and will thus not allow sufficient revenues to be garnered to sustain the envisaged GDP growth. It is recognised further that other countries are trying to move away from exclusive dependence on fossil fuels and that global treaties on carbon emission reductions require relevant policy changes in order to react to the new circumstances.

The impact on the national economy is mentioned as being the most prominent driver for triggering a change in the energy sector – including petroleum production and electricity provision. Mitigation of climate change and protection of the environment play a far smaller role. By aiming at including these aspects into education and awareness programmes, this may change in the future, i.e. during or after implementation of the Vision's plan.

The objectives for the development of the energy sector are based on the assumption that, in order to achieve the Vision 20:2020 targets, Nigeria will follow an energy intensive growth trajectory, similar to other emerging or developing countries (India, China). The Vision document set forth a strategic roadmap for power generation with three different horizons:

- Horizon I (short-term): a 6 GW capacity base by 2009 achieved by rehabilitation of the existing Power Holding Company of Nigeria (PCHN) plants and completion of on-going IPP projects;
- Horizon II (medium-term): encouragement of IPPs to increase capacity at their plants and putting ongoing NIPP projects on fast-track shall more than triple the capacity to 20 GW;
- Horizon III (long-term): the plan is to achieve the final target capacity of 35 GW by adding large hydropower schemes, coal-fired power facilities and renewable energy plants through the IPP model.

The Vision documents do not mention any analysis of estimated demand or load expressed in energy consumed but simply establish capacity targets.

Since these plans require a considerable amount of investment – with the expectation being that this is mainly driven by the private-sector – the Vision creates an environment that is purportedly attractive to outside investors. The idea in the Vision is to achieve this by further liberalisation and a transparent regulation, provision of guarantees for investments and allowance for a reasonable rate of return.

Measures proposed to achieve the targets include:

- The promotion of alternative technologies which include hydro, wind, solar, biomass, coal and nuclear – all with the goal of decreasing reliance on gas-fired plants. This statement ironically contradicts other stipulations in the Vision document, such as the fact that reducing the dependency on external markets does not sit well together with the plan to use nuclear power and coal-based generation as major energy supply sources, whereas the share of gas (a source which could be easily combined with renewable energy systems) shall be decreased.
- An increase in training efforts by strengthening the National Power Training Institute of Nigeria (NAPTIN)
- An enforcement of transmission capabilities, system redundancies, demand-side management, introduction of energy efficiency measures in industry, enlargement of the gas network for supplying gas-fired power plants
- Complete privatisation of the distribution systems (DISCOS) including billing and factorisation.
- Broad adoption of renewable energy technologies (RET) for electrification and heating in the context of rural and semi-urban settlements.

Over and above these general plans, the dedicated energy working group detailed the Vision's goals further and redefined them slightly. This led to the following global priorities, namely to:

- Attract private investments for a capacity increase in all subsectors
- Consolidate and complete the ongoing efforts to establish effective institutions and an appropriate regulatory environment;
- Enhance supply security by utilisation of renewable energy sources
- Reinforce and broadly expand local content in all energy subsectors (oil and gas, electricity)
- Foster sustainable generation and consumption patterns.

For each of the subsectors, further objectives, goals, strategies and initiatives were outlined which will help to achieve the overall vision targets described. The objectives were stipulated quantitatively per subsector (oil, gas) and per technology. These clear goals were underpinned by the respective strategy necessary to drive the initiatives described. The group has also listed the time-frame (short, mid, long term) for the required activities and the authorities required executing these.

Vision 20-2020 recognises the importance of Nigeria's renewable energy resource potential in meeting national electricity targets. Therefore, it called for various measures and strategies as contained in the document to support the sustainable integration of renewable energy generated electricity into the energy mix of the country. Some of the goals highlighted in the document include:

- chieving a 15% and 20% contribution of hydropower to the nation's electricity generation mix by 2015 and 2020 respectively;
- ensuring a 1% contribution of wind energy to the nation's electricity generation mix by 2020;
- attaining a 1% contribution of solar energy to the nation's electricity generation mix by 2020;
- replacing 50% of firewood consumption for cooking with biomass energy technology by 2020;
- putting in place an power generation capacity of 1,000 MW using biomass resource;
- maintaining a biofuel blend not exceeding 10% in transport fuels by 2020 using locally produced renewable biofuels from secondary biomass

The Jonathan administration has responded to the need for a holistic transformation of Nigeria in its Transformation Agenda, which covers the period 2011-2015. This Transformation Agenda is based on the Nigeria Vision 20:2020 and the 1st National Implementation Plan (NIP). [56]

5.4.10 Renewable Energy Master Plan, 2005 and 2012 (Update)

The Renewable Energy Master Plan (REMP), drafted by the Energy Commission of Nigeria and the United Nations Development Programme (UNDP) in 2005 and reviewed in 2012, expresses Nigeria's vision and sets out a road map for increasing the role of renewable energy in achieving sustainable development [ECN; Nov 2012]. The REMP does not specifically differentiate between on-grid and off-grid generation, however, it refers to integrating renewable energy into buildings, electricity grids and "other distribution systems". [ECN; 2013]

Simultaneously to the overall increase in power supply from renewable energy sources, the REMP targets higher electrification rates, from 42% in 2005 to 60% in 2015 and 75% by 2025. However, in this context it is important to note that the REMP has still not been signed off by the government or formulated into a law governing the renewable energy development. Only once that has happened, investors will have a clear path for drawing on the various financial incentives envisaged, such as pioneer status (tax exemption) and custom duty waivers.

It stresses the importance of solar power in the country's energy mix. Based on the, Nigeria intends to increase the supply of renewable electricity from 13% of total electricity generation in 2015 to 23% in 2025 and 36% by 2030. Renewable electricity would then account for 10% of Nigeria's total energy consumption by 2025.

The master plan also includes topics that are common to all subsector programmes, such as:

- The legal, regulatory and institutional framework,
- Incentives (financial and fiscal, e.g. tax exemptions),
- Capacity building (human and infrastructural),
- Inter-agency/governmental collaboration,
- Research and development,
- Monitoring and evaluation,
- Renewable energy portfolios and feed-in-tariffs.

5.4.11 National Renewable Energy and Energy Efficiency Policy (NREEEP), 2015

The National Renewable Energy and Energy Efficiency Policy (NREEEP) outlines the global thrust of the policies and measures for the promotion of renewable energy and energy efficiency. NREEEP seeks to bring to the attention of policymakers the economic, political and social potential of renewable energy. It recommends that an appropriate strategy should be developed to harness these potentials in order to add value to the ongoing changes in Nigeria's power sector. The document also stipulates that existing policies lack a coherent and all-encompassing framework that drives the sector and therefore calls for an integrated renewable energy and energy efficiency policy which will serve as a useful vehicle that limits conflicts in the future and promotes development and deployment of renewable energy technologies in Nigeria. It can be regarded as an umbrella document consolidating the various other afore-mentioned policies and strategies in one document. NREEEP was developed by the FMP in 2013/14 [FMP; March 2014] and has been approved by the Federal Executive Council in May 2015.

This policy encourages the development of a national renewable energy action plan and a national energy efficiency action plan which will facilitate the overall achievement of the objectives it sets out. The NREEEP recognises the multi-dimensional nature of energy and therefore addresses diverse issues such as renewable energy supply and utilisation; renewable energy pricing and financing; legislation, regulation and standards; energy efficiency and conservation; renewable energy project implementation issues; research and development; capacity building and training; gender and environmental issues; planning and policy implementation. The overall focus of the policy is on optimal utilisation of the nation's energy resources for sustainable development.

This policy on renewable energy and energy efficiency sets out a framework for action to address Nigerians' challenge of inclusive access to modern and clean energy resources,

improved energy security and climate objectives. It aims at raising the national significance of renewable electricity generation activities by providing for the development, operation and maintenance, and upgrading of new and existing renewable electricity generation activities.

While meeting ECOWAS's regional policy targets for renewable electricity generation and energy efficiency for 2020 and beyond, the policy declares energy efficiency to be a major, low-cost, and under-utilised source of energy offering savings on energy bills, opportunities for more jobs, improving industrial competitiveness, and lowering air pollution. As poverty mitigation and environmental protection are hindered by the continued predominance and inefficient use of oil and natural gas in meeting targeted energy needs, the policy broadens the definition of energy security to include renewable energy and energy efficiency as equally important indigenous sources of energy, in addition to oil and gas.

The policy includes provisions for renewable energy and energy efficiency generation activities into government policy statements and plans and thus recognizes the importance of enabling framework conditions for private investment in renewable energy and energy efficiency.

The Ministry of Power is set to develop of an integrated resource plan (IRP) and ensure the continuous monitoring and review of the implementation and effectiveness of the action plans prescribed under the national policy statement. Furthermore, the FMP is to facilitate the establishment of a framework for sustainable financing of renewable energy and energy efficiency projects and programmes in Nigeria.

The situation and expansion path for the renewable energy sector is described in Chapter 6 – On-Grid Renewable Energy while the status and development of energy efficiency is detailed in Chapter 7 – Energy Efficiency.

5.4.12 Multi-Year Tariff Order (MYTO)

The Multi-Year Tariff Order (MYTO), which is set to cover a total of 15 years going forward and is reviewed biannually, sets a feed-in bandwidth in order to ensure there are clear rules in the interim market. The MYTO II policy document states:

"In Nigeria, the true cost of electricity production is not reflected in the consumer tariff. MYTO II is intended to be cost-reflective and provide financial incentives for urgently-needed increased investments in the industry. These investments, in turn, lead to a significant and continuous improvement in the quantity of energy and quality of service enjoyed by the consumer (...). NERC has determined that the price of electricity to be paid to generators will be at the level required by an efficient new entrant to cover its life cycle costs (including its short-run fuel and operating costs and its long run return on capital invested) (...). It is pertinent to note that feed-in tariffs have been developed for investors wishing to invest in generation capacity that utilises other sources of energy including solar, wind, biomass and small hydro." [NERC; Jun 2012]

In January 2015 MYTO 2.1 was put into effect. The updated MYTO financial model now has the costs of each GENCO treated separately. Power Purchase Agreements (PPAs) prices have been obtained from Nigerian Bulk Electricity Trading Plc (NBET) and the model now recognises the following types of PPAs:

- Successor thermal,
- Successor hydro,
- NIPP thermal,
- Olorunsogo,
- Omotosho,
- AES,
- Agip,
- Shell,
- Ibom Power,
- Rivers IPP,
- Trans Amadi and
- Omoku.

MYTO II sets the feed-in tariff for the following categories of generation (which have not been amended by MYTO 2.1):

- new-entrant gas power plants
- new-entrant coal-fired power plants
- small hydropower plants
- land-mounted wind power plants
- solar power plants

The details of the Multi Year Tariff Order (MYTO) and the implications of a feed-in tariff system are outlined in detail in Chapter 6.

5.4.13 Draft Rural Electrification Strategy and Plan (RESP), 2015

Rural electrification is coordinated at the federal level, whereby implementation is at the state level. The draft RESP, which is also an outline of the policy as innate in the EPSRA section on rural electrification. RESP is a national document that applies at the same time to the states and local government areas. According to a draft version of April 2015, it proposes that: "The primary objective of the Nigerian Rural Electrification Policy and by extension this Rural Electrification Strategy and Implementation Plan is to expand access to electricity as rapidly as can be afforded in a cost-effective manner. This implies full use of both grid and off-grid approaches, with subsidies being primarily focused on expanding access rather than consumption." It seeks to do so by "promoting a full menu of rural electrification options, grid, off-grid, mini-grid and standalone systems". [FMP; 2015]

The relevance to rural electrification is outlined in Chapter 8.3.1.

5.5 Key Electricity Market Regulations

In the following, key regulations for the electricity market are referred to. The main regulations are:

- Transmission, Distribution and Metering Codes
- Embedded Generation Regulations NERC, 2012
- Regulation for Independent Electricity Distribution Network (IEDN), 2012
- Regulations on the Procurement of Generation Capacities, 2014
- Regulations on National Content Development, 2014

5.5.1 Transmission, Distribution and Metering Codes

The Nigerian electricity networks are governed by two main codes, the National Grid Code for the Transmission System (Tx) and the Distribution Code (Dx). For commercial operation of a power plant the Metering Code is another important document and provides details on the limits of supply and invoicing. All codes currently in force refer to related sections in the Electric Power Sector Reform Act. [35]

The Grid Code and Distribution Code of Nigeria describe in a clear and consistent way the requirements for synchronous generators connected to transmission levels and embedded generators. However, renewable generators are not specifically addressed either in the connection conditions of the Code or in the Operation Code. This mainly includes requirements for the behaviour of renewable generators during network disturbance (e.g. FRT capability, voltage support during grid faults; Reactive power capability during partial load operation; and Frequency control/Active power requirements). Such renewable energy-specific stipulations are likely to be added in the current review process of the codes.

5.5.1.1 Transmission Code

The Grid Code stipulates the conditions for the electricity transmission system in Nigeria. According to [EPSRA; 2005], the Transmission Company of Nigeria (TCN) is tasked to guarantee functioning transmission system operations of the high-voltage network and is responsible for overseeing operations. The code is the reference document for the day-to-day operating procedures and principles

governing the development, maintenance and operation. It was designed with two goals in mind: facilitating efficient production and supply of electricity for all users of the transmission system and TCN itself, on the one hand, and enabling competition in the generation and supply of electricity in the country, on the other. Thus, it is mandatory for all users of the transmission system, including TCN, to comply with these prescriptions. The document is being reviewed by the dedicated Grid Code Review Panel. [34]

The code is prepared in a well-structured manner explaining the background, scope and application of the document itself, establishes principles for system planning including load forecast, expansion planning, user involvement and requirements for relevant data. The key section from a plant developer's and operator's point of view is the chapter on connection conditions. It details the requirements on the performance characteristics with the principal parameters such as frequency and voltage, the sequence and conditions of the connection process and generally specifies the SCADA system (substation control and data acquisition), telecommunication and data exchange. The last chapter dealing with the system operation is important for keeping up availability, stability and performance, and includes provisions for the processes and situations that occur during the operation: system control with voltage and frequency regulation, reserve operation, emergency handling, planning of system operation, necessary information exchange, scheduling and dispatch, testing and safety rules.

GIZ under its Nigerian Energy Support Programme has made recommendations for specific definitions for renewable energy schemes which will be integrated into subsequent updates.

5.5.1.2 Distribution Code

Based on the EPSRA, the document is the reference for all distribution networks operated by the DISCOs that perform the functions of distributing electricity in networks in the voltage range from 240 V up to Kev. By law, the DISCOs are responsible for overseeing network operations and retail sales of electricity. [35], [40]

To support this function the Distribution Code (DCode) establishes a Distribution Code Review Panel and regulates how unforeseen circumstances beyond technical definitions of the document shall be handled. The first chapter explains the processes during distribution planning with requirements on the relevant planning data, planning documents, load forecasting, exigencies on distribution planning and system studies. Conditions for alterations of the system by new connections or modification are governed in Section 3, starting with the application process including connection agreements and describing commissioning, showing ownership boundaries (i.e. limits of supply). The most important part for the system designer is Section 4, which states the details of the requirements of the grid connection point including frequency, voltage, protections and grounding, standards, requirements on generators with the definitions of the connection point. The DCode regulates operations including planning, system texting and safety prescription and concludes with construction and maintenance provisions.

Given the nature of the document as a general code for the distribution networks of various types and characteristics of the different DISCOs, the Code avoids being very specific on technical parameters and sequences or procedures. Instead, it stipulates responsibilities, rights and duties for information, agreement and relevant processes between the responsible parties. For detailed technical specifications, parameters and settings, a consultation process between the corresponding DISCO and the participants of the system (generation facility or consumers), called the user, is still required. The connection agreement between the DISCO and the user is therefore the essential result of the consultation defining the conditions into more detail. In this sense, the DCode makes reference to standards and prudent industry practice

without further detailing the standard or actual method to be employed.

5.5.1.3 Metering Code

The last overall document which can be regarded as essential for the set-up of a commercial project is the Metering Code [35]. It covers metering in the transmission system and the distribution networks. It defines the conditions and requirements for electricity meters in the country. Important for the developers and owners of energy projects is the type and characteristics of the metering devices, description of exchange of acquired data and the location of the meters. The location of the meter is very important since it marks the commercial limits of supply and thus of responsibility for the interconnection line losses.

5.5.2 Embedded Generation Regulations, 2012

In the Embedded Generation Regulations NERC defines the standard rules for embedded generators and the operation of electricity supply systems. It equally describes the responsibility of distribution planning including forecasting of demand, analysis of the impact of new connections, grid expansion planning, monitoring and solving supply quality problems, execution of necessary studies and attributes these to the holders of distribution licenses. [37]

Embedded generation is defined as generating units that are connected to the distribution grid. The definitions as listed in Table 5 – 1 apply.

If embedded generation units are to be connected to the distribution network, then this shall be done in accordance with the Distribution Code. However, embedded generation providers are not obliged to provide electricity to the public. In addition, operators of renewable energy power systems shall ensure that where storage is not required, flexible generation exists to allow the intermittent and uncertain power to be absorbed into the grid on a priority basis. The regulation prescribes that the licensee shall enter into the various network agreements such as a power purchase agreement, a connection agreement/interface agreement, a use of networks agreement, and an ancillary services agreement with the relevant authorities, such as NERC and NBET, as further detailed in Chapter 6.5.

5.5.3 Regulations for Independent Electricity Distribution Networks (IEDN), 2012

This document states the necessary provisions for the issuance of licences for distribution network operators and electricity distributors independent of a distribution company. An Independent Electricity Distribution Network (IEDN) entails all isolated rural or urban networks not connected to the national grid and embedded networks. An IEDN is required either to operate its own generator or to obtain electricity from another distribution company via a service agreement. [NERC; 2012]

After a definition of licences and their application, the procedures state in detail how these permits will be granted, establish the conditions for operation of the networks including provisions on the detailed evacuation capacities to be foreseen per plant type or peak capacity,

TABLE 5 – 1:
EMBEDDED GENERATION - LICENSING DEFINITIONS

Rated Capacity	Connection Voltage Level
Small units with 1 MW - 6 MW	11 kV medium distribution voltage
Large units with 6 MW - 20 MW	33 kV medium distribution voltage
≥ 20 MW	33 kV medium distribution voltage for every 20 MW being evacuated

Source: [NERC; Jan 2012]

and finally conclude with the obligatory definition of terms.

5.5.4 Regulations for the Procurement of Generation Capacity, 2014

The Regulations for the Procurement of Generation Capacity, 2014 issued by NERC, sets out rules and requirements for the acquisition of additional generation capacities by a licensed buyer authorised to trade electricity from generation companies. The regulation requires that any such procurement shall be done via a competitive tender process. The objective is to establish clear instructions, specify technical standards, enable full transparency on that process and facilitate the involvement of the private sector. The definition extends to any generation system being connected to the transmission system or an embedded generator in the distribution network.

The procedures include the procurement process (expression of interest followed by a request for proposals), criteria of bidders and their qualification, requirements for requests for proposals, the bidding process and the implementation of the contract including PPA. Further to the central aspects, the communication protocols as well as auditing and control procedures are defined.

The regulation includes all transactions for generation facilities beyond the lower threshold ("small power plants") of 10 MW. The main actor in the process is the future buyer (currently only NBET) of the additional capacities while its procedures are overseen and approved by NERC. The regulation only outlines the structure, sequence and formal requirements for the process. The actual criteria and detailed conditions (often subject to the specific technology or project) are not part of the document.

5.5.5 Regulations on National Content Development, 2014

In December 2014 the NERC enacted the "Regulations on National Content Development for the Nigerian Electricity Supply Industry". Its main goal is to increase the employment of domestic goods and staff as well as to strengthen Nigerian companies in the electricity sector.

The intention of the regulation reads as follows:

- Deliberate utilization of Nigerian human and material resources, goods, works and services in the industry;
- Opening the NESI at all levels of its complexity to involve Nigerian people and expertise;
- Building capabilities in Nigeria to support increased investment in the industry;
- Leveraging existing and future investment in the NESI in an effort to stimulate growth of Nigerian and Nigeria-located enterprises.

Licensees under the Electric Power Sector Reform Act 2005 are required to give primary considerations to Nigerian employment and training, goods and services, including insurance, financial and legal services. Depending on the scope of the activity the NERC requires development plans and periodic reports. The Commission reviews reports and can issue directives. [NERC; 2013]

Renewable energy is energy which can be obtained from natural resources that can be constantly replenished. Types of renewable energy technologies include, in alphabetical order:

- Bioenergy
- Geothermal energy
- Small hydropower
- Tidal energy
- Solar energy
- Wind energy

Renewable energy technologies also include hybrid and related technologies. This chapter refers to large capacity "on-grid" renewable energy technologies with the potential to provide electricity as a generation company (utility-scale IPPs). In Chapter 8 we refer to renewable energy as means of rural electrification, i.e. small-scale "off-grid" systems.

6.1 On-grid Renewable Energy Market

6.1.1 The Potentials

The Renewable Energy Master Plan (REMP) in its second draft of November 2012 as prepared by the Energy Commission of Nigeria seeks to increase the supply of renewable electricity from 13% of total electricity generation in 2015 to 23% in 2025 and 36% by 2030. Renewable electricity would then account for 10% of Nigerian total energy consumption by 2025 [ECN; Nov 2012]. The REMP, although not ratified, identifies the following potentials:

TABLE 6 – 1:
RENEWABLE ENERGY POTENTIALS

Resource	Potential	Current Utilisation and further remarks
Large Hydropower	11,250 MW	1,900 MW exploited
Small Hydropower	3,500 MW	64.2 MW exploited
Solar	4.0 kWh/m2/day – 6.5 kWh/m²/day	15 MW dispersed solar PV installations. (estimated)
Wind	2–4m/s @ 10m height mainland	Electronic wind information system (WIS) available;
Biomass (non-fossil organic matter)	Municipal waste	18.5 million tonnes produced in 2005 and now estimated at 0.5kg/capita/day
	Fuel wood	43.4 million tonnes/yr. fuel wood consumption
	Animal waste	245 million assorted animals in 2001
	Agricultural residues	91.4 million tonnes/yr. produced
	Energy crops	28.2 million hectares of arable land; 8.5% cultivated

Source: [ECN; 2013]

However, the viability of wind as a primary energy source needs to be investigated more diligently before any further recommendations can be made. The REMP lists wind speed figures at a height of 10 metres above the ground. This figure is not very relevant for large-scale wind farms. Detailed wind measurement campaigns are necessary to identify potentials. The solar energy potential is given as a figure in kWh/m² and day. Yet, the method of measuring (Direct Normal Irradiation; DNI), Global Horizontal Irradiation (GHI) and Global Tilted Irradiation (GTI)) is not indicated. Thus the pure figure may be misleading for project developers. Moreover, the figures for biomass (non-fossil organic matter) are not substantially described for developers to get a concrete idea the potential of this technology. Finally, the hydro power potential might have been overestimated: Initial re-assessments of feasibilities studies for selected micro-hydro sites reveal that the commercial viability is seriously limited by the seasonal variation of the water flow (see also Chapter 6.1.1.2).

Below we depict the potentials for large-scale renewable energy in detail.

6.1.1.1 Bioenergy / Biomass / Biofuel

Data covering biomass projects or companies active in the sector is unavailable, since there is no central body responsible for this segment, which cuts across various ministries as well as federal, state and local government levels. One exception is the Jatropha Growers Association[19]. While there are numerous very small-scale projects mooted, any figures on total volume would be guesses.

However, a variety of biomass resources exist in Nigeria in large quantities with opportunities for expansion. Biomass resources include agricultural crops, agricultural crop residues, forestry resources, municipal solid waste and animal waste. Agricultural crop residues include those produced from the processing of crops. The agricultural crops that have potential as biomass feedstock for biofuel production include sugar cane, cassava, rice, maize and sorghum for ethanol and oil palm, groundnut, coconut, cotton, soybean, Jatropha and sesame (locally called biniseed) for biodiesel. [Agba A.M., Ushie M.E., Abam F.I., Agba M.S., Okoro J; 2010]

Another source of biomass is municipal solid waste (MSW), which is generated by households, commercial and industrial sectors as result of concentration of population, and is collected with vast majority disposed of in landfill dumps. The waste takes many forms including plastics, paper, textiles, glass, metal, wood, and other organic waste. Municipal solid waste can be converted into energy by direct combustion, or by natural anaerobic digestion in the landfill. At landfill sites, the gas produced by the natural decomposition of MSW (approximately 50% methane and 50% carbon dioxide) is collected from the stored material and scrubbed and cleaned before being fed into internal combustion engines or gas turbines to generate heat and power. The organic fraction of MSW can be anaerobically stabilised in a high-rate digester to obtain biogas for electricity or steam generation. According to a study in 2009 about 25 million tonnes of municipal solid waste are generated annually in Nigeria. [Ogwueleke T.; 2009]

From the perspective of available land and wide range of biomass resources, Nigeria has significant potential to produce biofuels and even become an international supplier. Bioenergy feedstock is not only abundant in Nigeria, it is also widely distributed. Nigeria is the largest producer of cassava in the world. Nigeria could also become a major player in the biofuel industry given the enormous magnitude of various waste / residues (agricultural, forestry, industry and municipal solid) available in the country.

The World Bank in its "Low Carbon Report", while firmly advocating the use of solar PV, also suggests *"other sources of power include using municipal waste to generate methane to generate power, combusting other biomass to make power, and small-scale (micro or pico) hydropower. (...) These technologies are promising and advantageous with*

[19] National workshop on Jatropha for sustainable energy development, 6th – 7th may 2008

suitable local conditions, and are well worth pursuing." [WB; 2013]. It is suggested that by 2015 biomass-to-power could deliver as much as 1,643 GWh/year, with the figure rising to 13,140 GWh/year by 2035. Worthy of mentioning here are the attempts by the Lagos Waste Management Authority to investigate methods for generating power with the waste they collect as an alternative to opening up new landfills. With similar forms of waste collection in place in Abuja, Kano and Port Harcourt, and the very large volumes of waste accumulating there, the potential for waste-to-power projects in the large conurbations needs to be investigated in greater detail.

To date, there has been little mention of any plans to establish large biomass power plants, for example along the model developed in Brazil for sugarcane plantations, where the crushed fibres (bagasse) are used as the feedstock to great effect. This is even more surprising given the prevalence of academic literature demonstrating the biomass potentials on the ground in Nigeria. Using the huge quantities of biomass resources, mostly in the form of agricultural residues and waste for energy production could potentially increase the energy supply thereby increasing energy mix and balance in Nigeria. [Simonyan, K.J. & Fasina, O.; 2013] or [Audu, T. & Aluyor, E.; 2012]; and [Agbro, E. & Ogie, N.; 2012]

Table 6 – 2 summarises the potential of residues from agricultural crops in Nigeria at approximately 1,958 PJ (or 543,890 GWh) per annum.

TABLE 6 – 2:
RESIDUES ESTIMATE FROM AGRICULTURAL CROPS, 2010

Crop	Production ('000 t)	Component	Weight available in million tons	Total energy available (PJ)
Rice	3,368.24	Straw	7.86	125.92
		Husk	1.19	23.00
Maize	7,676.85	Stalk	10.75	211.35
		Cob	2.10	34.19
		Husk	0.92	14.32
Cassava	42,533.17	Stalks	17.01	297.68
		Peelings	76.56	812.30
Groundnut	3,799.25	Shells	1.81	28.35
		Straw	4.37	76.83
Soybean	365.06	Straw	0.91	11.27
		Pods	0.37	4.58
Sugar cane	481.51	Bagasse	0.11	1.99
		Tops/Leaves	0.14	2.21
Cotton	602.44	Stalk	2.25	41.87
Millet	5,170.45	Straw	7.24	89.63
Sorghum	7,140.96	Straw	7.14	88.39
Cowpea	3,368.24	Shell	4.89	95.06
Total			**145.62**	**1,958.94**

Source: [Simonyan, K.J. & Fasina, O.; 2013]

6.1.1.2 Hydropower

The Ministry of Power classifies the hydropower plants that have a generating capacity of less than 30 MW as small and of less than 1 MW as mini hydro, while plants large than 30 MW / 100 MW are classified as medium and large hydro respectively [FMP; 2015]. Currently there are 1.9 GW hydropower capacity installed in 3 large power plants (Kainji: 760 MW; Jebba: 570 MW; Shiroro: 600 MW), although only roughly half of it is operational (cf. Annex 3, Table A – 8). A World Bank reference scenario following FGN plans and feedback from stakeholders suggests hydropower utilisation could be increased to 7.2 GW by 2035. [WB; 2013]. The ECN estimates the large hydro potential even at 11 250 MW and the small hydro potential at 3 500 MW (cf. 6.1.1). As shown in Figure 6 – 1, various dams are available for retrofitting with hydropower plants.

However, this potential has to be assessed carefully: A recent GIZ study [GIZ; 2015)] based on a data set provided by JICA suggests that hydropower potential might be more limited. Figure 6 – 2 shows flow patterns vary considerably between wet and dry season. The large seasonal variation (some rivers only showing 5 to 10 % of flow in the dry season) may significantly restrict the economical viable potential for hydropower in the country. This is particularly true for run-of-river plants typically applied for small and mini hydro power.

FIGURE 6 – 1:
LOCATION OF MAJOR DAMS IN NIGERIA

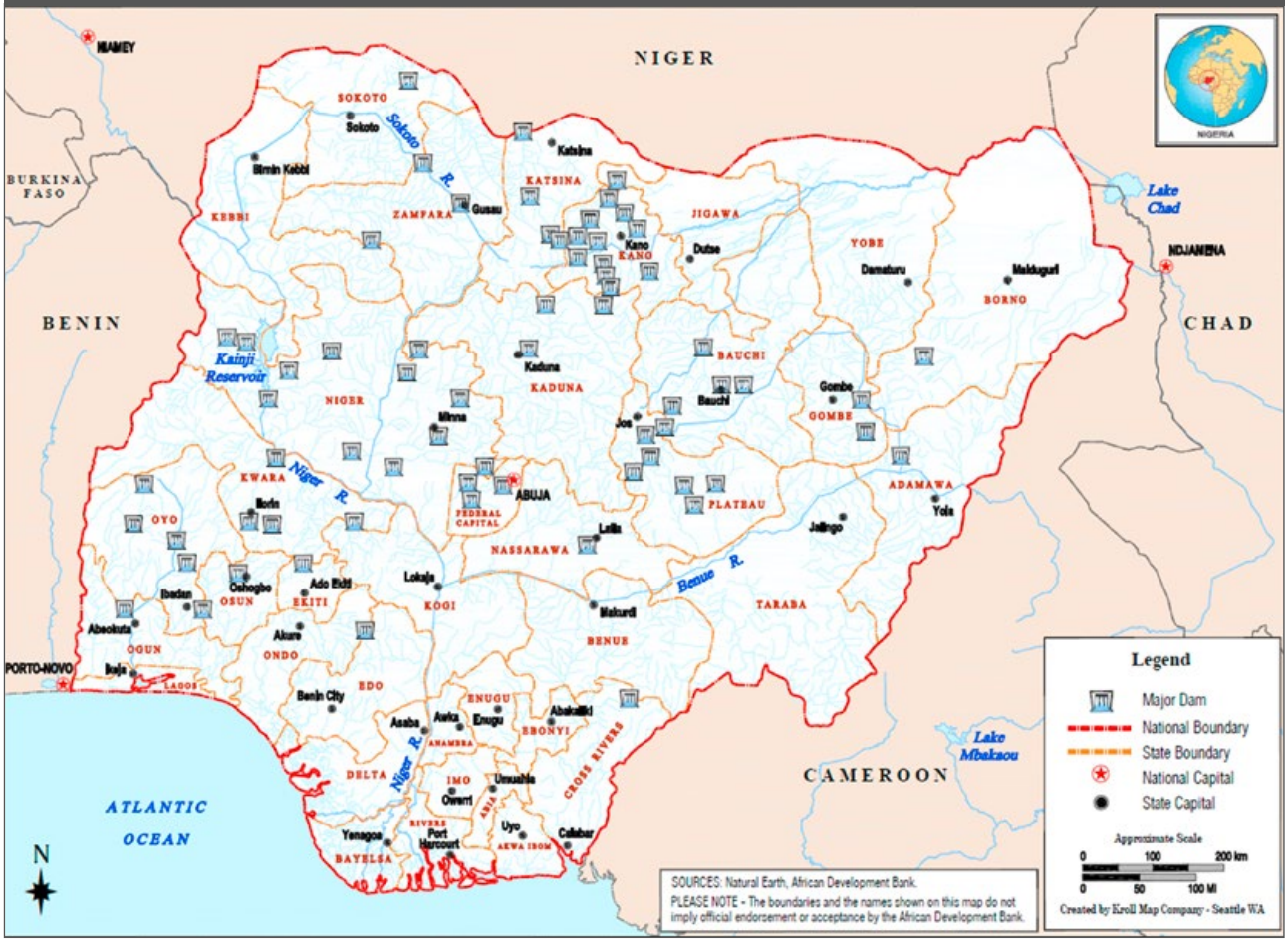
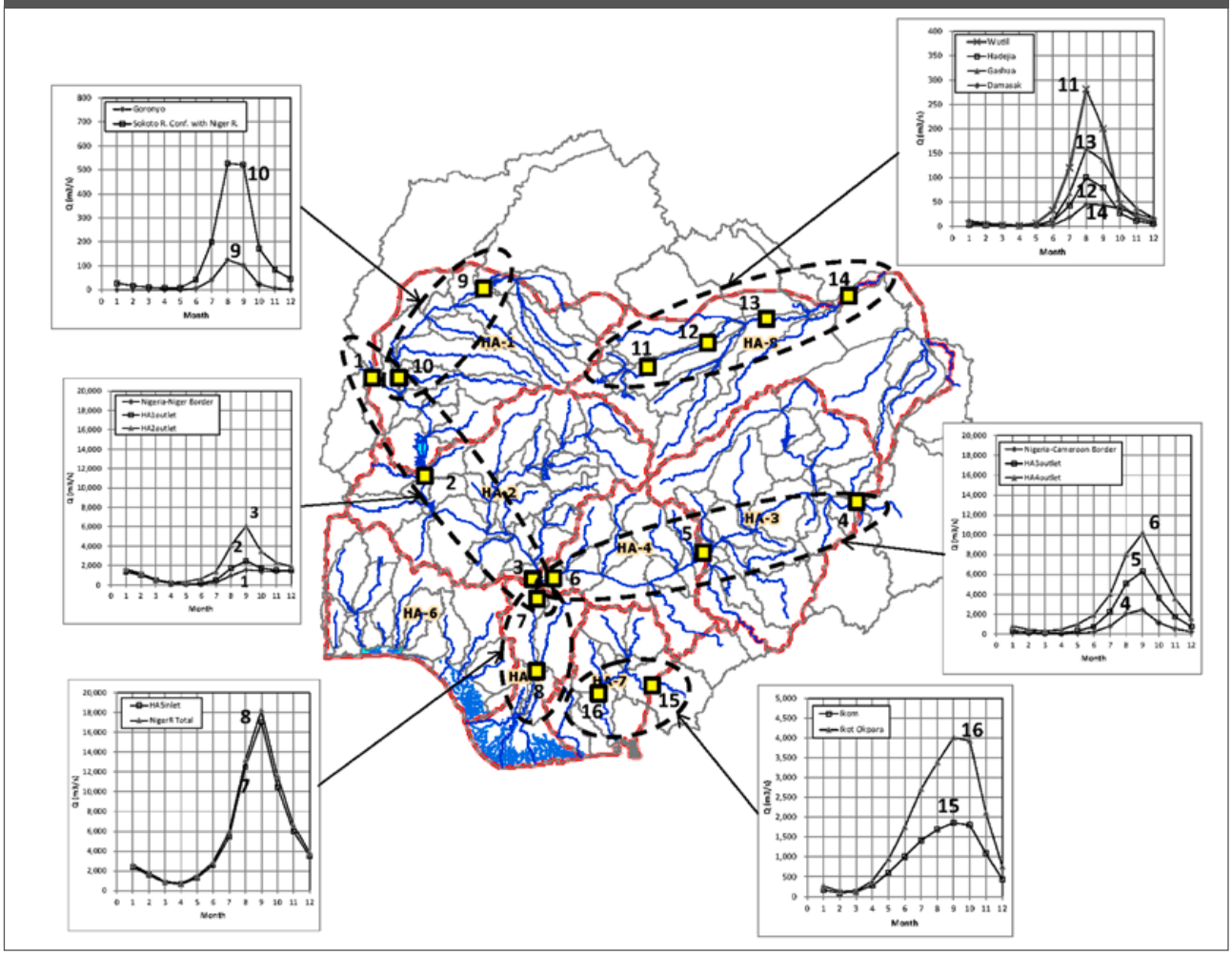


FIGURE 6 – 2:
HYDRO POTENTIAL: SEASONAL FLOW PATTERN AT REPRESENTATIVE POINTS



Source: [GIZ; May 2015] based on data from JICA; time-frame of data used: 1970 – 2009

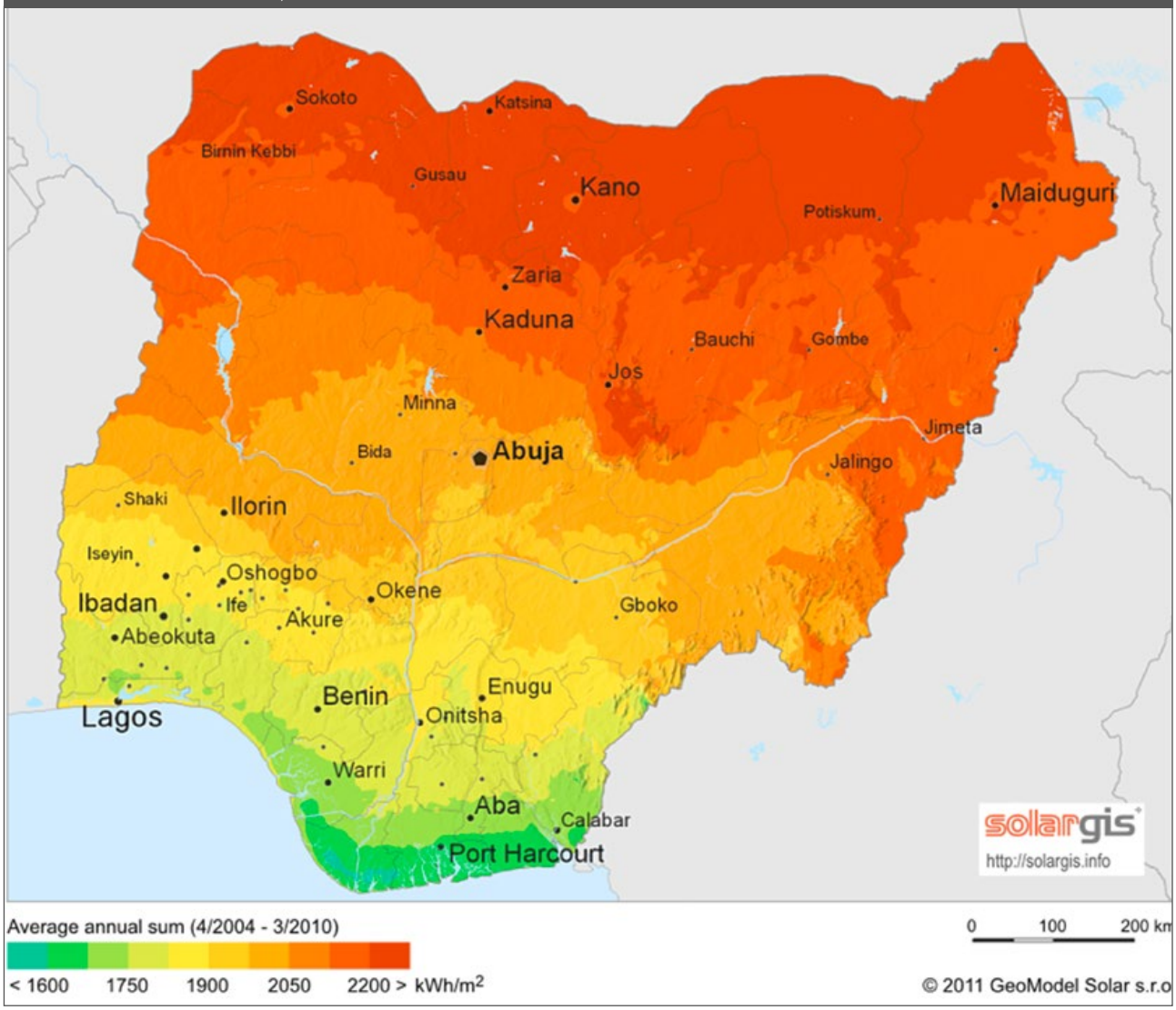
6.1.1.3 Solar Energy

Nigeria has a potential for electricity production from Solar PV technology in the range of 207,000 GWh per year if theoretically only 1% of the land area (e.g. 920 km^2 = 920*106 m^2) were covered with state-of-the-art poly-crystalline PV modules,[20] with an electricity yield of 1,500 Wh/Wp per year. This figure is tenfold the total electricity production of Nigeria in 2011 (cf. Figure 3 – 6).

[20] p-Si Module, 150Wp per m^2

Flat-plate photovoltaic devices utilise both diffuse and direct radiation. Since Nigeria has a better potential for photovoltaic systems than for concentrating optical equipment, Figure 6 – 3 shows the irradiation levels of global horizontal irradiation (GHI) in Nigeria.

FIGURE 6 – 3:
SOLAR IRRADIATION LEVELS, GHI



As can be seen from the map in Figure 6 – 3, the best potential for large-scale solar power plants (preferably PV) lies in the northern part of the country. Long-term annual average GHI values in the northern states ranges from 2,000 to 2,200 kWh/m². This high solar irradiation is comparable to very high-yield sites in southern Spain, northern Africa, Australia and Latin America. The south of Nigeria has less potential for solar energy as it is often cloudy and has a longer rainy season.

Solar PV Power Plant – an Example:

A 15 MWp solar IPP is under construction in Yola, in Adamawa State, giving a specific yield in average between 1,450 kWh/kWp and 1,650 kWh/kWp per year. For comparison, we calculate with a diesel generator producing same amount of electricity (66 MWh per day). Assuming a fuel efficiency of this equipment of 33% the diesel genset needs around 19,925 litres of diesel fuel and a truck transporting 20,000 litres of diesel from Warri to Yola every day. The return trip is 2,100 kilometres. This truck uses 630 litres diesel daily for the trip (30 litres diesel consumption per 100 kilometres). The solar PV plant in operation would thus substitute for around 7,502,600 litres of diesel fuel per year.

Specifically, the World Bank recommends in this context that off-grid solutions be developed using renewable energy sources, commenting that *"PV and hybrid systems are already economically competitive for many off-grid applications. Gasoline and diesel generators produce power at levelised cost of energy (LCOE) between US$ 0.23 and $0.42/kWh. The cost of electricity from PV and hybrid PV-wind-diesel systems are in the range of $0.30/kWh and $0.22/kWh, respectively. As the costs of renewables continue down the learning curve, and fossil fuel prices in Nigeria revert to global market prices ("export parity"), the economic advantages of renewables will become ever greater."* It proposes that solar PV in particular be used for water pumping and irrigation, as further detailed in Chapter 8.

The economic viability of solar PV is meanwhile beyond question. As mentioned earlier, this becomes doubly true if the location of the solar IPP is somewhere that is not close to a diesel depot and the investment case becomes increasingly strong if this can be converted into a carbon credit.

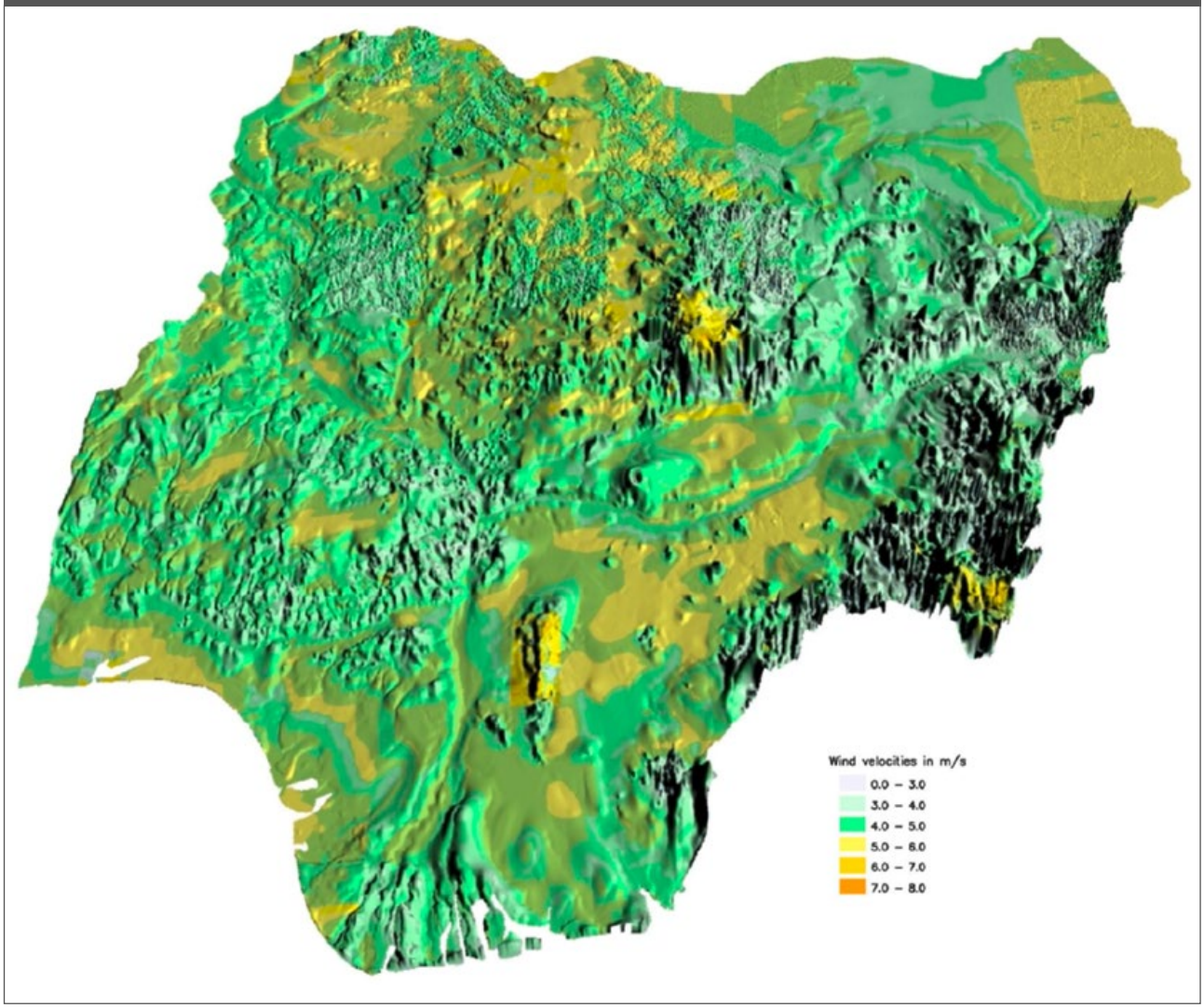
6.1.1.4 Wind Energy

The Ministry of Science and Technology has carried out wind energy resource mapping [Lahmeyer; 2005]. This wind mapping project indicated wind speed of up to 5 meters per second in the most suitable locations, which reveals only a moderate and local potential for wind energy. The highest wind speeds can be expected in the Sokoto region, the Jos Plateau, Gembu and Kano / Funtua. The stations at Maiduguri, Lagos and Enugu also indicated fair wind speeds, sufficient for energy generation by wind farms. Apart from these sites, other promising regions with usable wind potential are located on the Nigeria western shoreline (Lagos Region) and partly on the Mambila Plateau. The calculations indicate the highest energy yield at the coastal area of Lagos, followed by the Sokoto area and the Jos Plateau. The computed 3D wind map is shown in Figure 6 – 4 .

The afore-mentioned wind resource mapping was carried out on-shore. However, in the absence of a detailed wind mapping, constant speeds that would enable commercially viable power generation may only be obtained offshore. To date, the Federal Ministry of Power reports that an off-shore wind mapping is being undertaken [12]. However, no details about this have been disclosed. Such information would beneficial for further investigation of the potential of wind power in Nigeria.

There are two larger wind farm projects ongoing at present, namely 10 MW in Katsina, and 100 MW in Plateau State. As regards the 100 MW wind-power farm outside Jos, due diligence has been completed on the application for a license to operate. The owner reports that a provi-

FIGURE 6 – 4:
3D WIND MAP OF NIGERIA 80 M ABOVE THE GROUND



Source: Ministry of Science and Technology, Nigeria 2005

sional Independent Power Producer (IPP) license has been obtained from the National Electricity Regulatory Commission (NERC) acknowledging that JBS Wind Power Limited has met all regulatory requirements to commence operation [20]. The smaller 10 MW Katsina pilot wind farm is being built by a French company on behalf of the FMP and is about to be completed.

6.1.1.5 Other Resources

Presently, the potentials of some resources such as geothermal, nuclear energy, waves, tidal and ocean thermal gradient still remain untapped and unqualified. Nevertheless, a study has been conducted on geothermal power, e.g. by the Ahmadu Bello University, Department of Geology in collaboration with University of Silesia, Faculty

of Earth Sciences, Poland [Kurowska E., Schoeneich K.; 2010]. The study concluded that geothermal analysis based on geothermal gradients indicated areas of higher-than-average gradient values and geothermal anomalies within sedimentary basins. Further detailed studies are necessary to identify the potentials.

6.1.2 Existing and Planned Renewable Energy Projects

The nationwide potential for large-scale renewable energy projects is huge, especially for solar PV. Each technology has its specific challenges and many projects are under development for implementation. Existing large-scale grid connected renewable energy projects mainly take the form of large hydropower plants. To date, no real commercial large-scale project has been successfully implemented, other than hydropower (and small biomass, e.g. ethanol production.

NERC, the Federal Ministry of Environment and the Federal Ministry of Power all have programmes to support and implement various renewable energy technology projects in the near future (see the following sections).

Private investors and developers have obtained NERC licences for various projects, but none of these projects have yet been completed. However, some of these are at an advanced planning stage, such as e.g. the Anjeed Kafanchan solar project. The project is 15 MW grid-connected solar project located in Kafanchan, Kaduna State and is the first grid-connected solar plant to be awarded an Environmental Impact Assessment (EIA) certificate by the Federal Ministry of Environment in November 2013. The project is estimated to be completed in 2015. Other private companies such as e.g. SkyPower FAS Energy or Super Solar Nigeria have signed Memoranda of Understandings with the Nigerian government. However, the targeted project sizes (in this case 3 000 MW of solar power each) seem to be unrealistic. Synergent Powershare Group of Companies is investing in a 50 MW solar farm in Kaduna, officially initiated in September 2011. For further private sector driven project development activities see next section.

6.1.2.1 NERC Licensees

Some companies have applied to NERC for licenses for solar PV or wind power plants. Table 6 – 3 [21] lists approved licensees for unsolicited renewable generation by NERC as of 2014. [36]

TABLE 6 – 3:
NERC LICENSEES, RENEWABLE ENERGY

Name of Licensee	Capacity (MW)	Fuel Type	State	Geopolitical Zone
JAP Energy Limited	504	Biomass	Lagos	South-West
Premier Energy Limited	50	Hydrogen fuel cell	Adamawa	North-East
Rook Solar Investment Limited	50	Solar	Osun	South-West
Quaint Global Nigeria Limited	50	Solar	Kaduna	North-West
Nigeria Solar Capital Partners	100	Solar	Bauchi	North-East
Anjeed Kafanchan Solar Limited	10	Solar	Kaduna	North-West
Lloyd and Baxter LP	50	Solar	Abuja	North-Central
KVK Power Pvt Limited	50	Solar	Sokoto	North-West
Pan African Solar	54	Solar	Katsina	North-West
Mabon Limited	39	Hydro	Gombe	North-East
JBS Wind	100	Wind	Plateau	North-Central

[21] Latest information: NERC does no longer maintain this list of Licensees related to „fuel type“

It is worth mentioning that some of the licensees named in Table 6 – 3 are not actively pursuing the full capacity in their current projects. The licenced 504 MW biomass plant in Lagos, for example, will certainly not be implemented in one phase due to the immense investment that would be necessary. Actual figures (from private licensees) about the "real" capacities to be expected by implementing the projects in the near future are not available.

The full list of NERC licensees for power generation (on-grid, off-grid and embedded) is presented in Annex 3, Table A – 7.

6.1.2.2 Projects of the Federal Ministry of Environment

Under the Renewable Energy Programme the Federal Ministry of Environment (FMENV) has initiated several projects. [52] Global Biofuels Ltd is developing a biofuel production complex at Ilemeso in the northern part of Ekiti state of Nigeria. Similar plants are planned to be established at Ondo, Kwara, Osun, Oyo, Kogi, Kaduna, Kano, Zamfara, Benue, Plateau, and Nasarawa.

The Renewable Energy Programme office, Adamawa State Government and Green Carbon Afrique is developing sugarcane based biofuel plants in Girei and Demsa Local Government Areas of Adamawa State covering 2,000 hectares of plantations. This initiative is to produce sugar for local use and export, ethanol and ultimately electricity. This integrated project is being replicated in ten states of the country.

Currently, rice production and processing in Nigeria is typically undertaken by small local farmers using basic processing technology. Typical issues limiting economies of large-scale rice production include lack of access to improved technologies, the high costs of energy for parboiling, and lower output quality (post processing). However, working in conjunction with Carbon Quest and Adamawa State, the Renewable Energy Programme office is establishing an integrated "Rice Processing and Power Generating Facilitator", to the economic benefit of the investing state, garnering the advantages of large-scale rice production and self-generated power from the rice husks.

Considering the prospect of solar energy in a developing economy like Nigeria, the Synergent Powershare Group of Company is investing in a 50 MW solar farm in Kaduna which was officially launched by the Honourable Minister of Environment and Kaduna State Governor in September 2011.

6.1.2.3 Projects of the Federal Ministry of Power

Since large-scale projects in renewable energy are assigned to the private sector under the ongoing privatisation progress, the Federal Ministry of Power is no longer pursuing such projects. However, as of February 2014, the FMP has awarded several contracts to Nigerian consultants to undertake "consultancy services for wind, solar and biomass projects in different locations nationwide". [10] The consultancy contracts were all awarded in December 2013 and results from the studies are yet to come.

On the other hand, FMP is pursuing the development of large-scale hydropower projects. Table 6 – 4 lists hydropower development as of 2014. The projects are described as being at different stages of implementation. The major national projects are the Mambilla and Zungeru plants. While financing for the former has not yet been secured, the latter is loan-financed through China's Exim Bank.

TABLE 6 – 4:
HYDROPOWER DEVELOPMENT BY FMP, 2014

No.	Power Station	MW	Zone	Status
1	Zungeru project - Niger State	700	North Central	financing secured
2	Mambilla Project - Taraba State	3,050	North East	under development
3	Gurara II Project - Niger State	360	North Central	under development
4	Gurara I Project - Niger State	30	North Central	under development
5	Itisi Project - Kaduna State	40	North West	under development
6	Kashimbilla Project - Taraba State	40	North East	under development

Source: Federal Ministry of Power, [10]

In addition to the projects named in table 6 – 4, the FMP is engaged in the 10 MW Katsina Wind Project. The Ministry is currently evaluating the procurement of contractors for the erection of a 33 kV transmission line/ sub-station and wire mesh fencing of the project site. [15] The wind farm project has reached 98 percent completion and is currently undergoing test runs.

6.1.2.4 Projects of the Federal Ministry of Water Resources (FMWR)

In line with the policy directive of government to increase energy supply to meet the nation's energy demands, Federal Ministry of Water Resources (FMWR) is collaborating with the Federal Ministry of Power (FMP), with the latter handling the power generation component, while the FMWR handles civil works in the dam projects with hydropower potentials. Small hydropower schemes have been integrated into some dam projects across the country in order to increase the energy supply of the nation.

To date, FMWR has identified and carried out studies on some of the completed and on-going dam projects for hydropower, nineteen of which have the potentials for hydropower generation with a total capacity of 3,557 MW. These dams include; Gurara, Oyan, Ikere Gorge, Bakolori, Dadin Kowa, Tiga, Kiri, Jibiya, Challawa Gorge, Owena, Doma, Waya, Mgowo, Zobe, Kampe, Kashimbilla, Ogwashiku, Zungeru and Mambilla.

Two large-scale projects are under consideration of implementation, Kashimbila /Dadin Kowa (40 MW) close to Gombe in the North-East, and Gurara (360 MW) in Niger State, a few kilometres north of Abuja. The Ministry of Water Resources and Ministry of Power are working with Niger Delta Power Holding Company (NDPHC) on two other hydropower projects under the NIPP programme. The second phase of the NIPP programme shall eventually lead to the construction of 4 000 MW of hydro plants.

The FMWR has setup a new regulatory agency – the Integrated Water Regulation Commission – to address water concession issues for power and agriculture. This new commission regulates water concessions by the water resources act which is not yet gazetted. Special incentives for hydropower projects do not currently exist.

6.2 Renewable Energy Stakeholders

6.2.1 Public Authorities

Using the analysis of the mandates, roles, relationships and activities presented in Chapter 4, it is clear that FMP drives activities in the on-grid electricity from renewable energy sources. By extension, TCN, NERC and ECN all have pivotal roles to play in the renewable energy market. However, rather than having a symbiotic relationship, there seem to be overlaps especially when it comes to policy and strategy development.

According to its mandate, the FMP is the clear lead in policy formulation and implementation to promote a diversified electricity mix for the country including electricity generated from renewable energy sources. The inclusion of electricity generated from renewable energy into the power mix of the country is technically the responsibility of FMP, NERC and TCN.

FMWR is also becoming important in the sector. Due to its role in hydropower development (e.g. dam construction, hydrological activities etc.), its engagement in the near future will become more pronounced. Currently, it undertakes civil works on hydropower stations. Therefore, a strong relationship with the FMP could further promote more hydro generation capacity in the country.

The FMP currently leads the Inter-ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE), which is the key to coordination. ICREEE started to meet regularly in 2014 and is well positioned to address the overlap in activities and shortfalls in regulations and support programmes.

NERC as a national regulator also has an important role to play. Granting preferential tariffs is pivotal to achieving diversification in the electricity mix of the country. However, in line with the "Regulations on the Procurement of New Generation Capacities", the support mechanism of the Feed-in Tariff (FIT) system is likely to change to a competitive bidding system for large-scale renewable energy.

NBET is the state entity responsible for purchasing electricity from generation companies under long term Power Purchase Agreements (PPA) and selling it to distribution companies. NBET so far acts as single buyer for transmission-connected power, and hence would be responsible for the implementation of a bidding system for large-scale renewable energy.

FMENV plays a secondary role, as it has no direct mandate in the power sector. The Ministry approves Environmental and Social Impact Assessments.

Table 6 – 5 summarises the functions and roles of the public authorities in the renewable energy sector.

TABLE 6 – 5:
RENEWABLE ENERGY STAKEHOLDERS, PUBLIC AUTHORITIES

Main actors	Functions	Role in Renewable Energy
Federal Ministry of Power (FMP)	FMP is responsible for policies, programs and monitoring of the power sector in the country.	To promote a diversified electricity mix for the country including electricity generated from renewable energy sources. Drafted the National Renewable Energy and Energy Policy and leads the Inter-ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE)
Federal Ministry of Environment (FMENV)	The FMENV prepares comprehensive national policies for the protection of the environment and conservation of natural resources, including procedure for environmental impact assessment of all developing projects	Plays a secondary role, as it has no direct mandate in the power sector. It approves ESIA. In addition, FMENV grants tax holiday for utility scale PV plants.
Federal Ministry of Water Resources (FMWR)	The FMWR formulates National Water Resources policies towards ensuring adequate water supply for agricultural, industrial, recreational, domestic and other uses. It develops programmes and policies towards surface water storage schemes and guiding principles for dam construction nationwide	Role in hydro development (e.g. dam construction, hydrological activities etc.). Currently, the FMWR undertakes civil works on hydropower stations in cooperation with the FMP.
Nigerian Electricity Regulatory Commission (NERC)	NERC is a key organisation responsible for regulation of the power sector across power generation, transmission and distribution. NERC is responsible for the creation of a competitive power sector; establishment of operating codes and standards; licensing and regulation of persons engaged in any of the power subsector activities; tariff determination; approval of amendments to electricity market rules; and other related regulatory functions. It is governed by 7 commissioners, 6 from geopolitical regions and 1 designated Chairman/Chief Executing Officer (CEO).	NERC issues generation licenses to applicants in Renewable Energy and administers and implements preferential tariffs (e.g. the MYTO feed-in tariffs).
Energy Commission of Nigeria (ECN)	ECN's role as per the ECN Act is mainly research, data gathering and coordination.	The commission promotes the use of renewables and alternative energies via research, pilot project and strategy development. These ECN activities are carried out by the departments at its head office and the Energy Research Centres located at Nsukka, Sokoto, Lagos, Bauchi, Ilorin and Benin.
Nigerian Bulk Electricity Trading Plc (NBET)	NBET is the off-taker o electricity and inter alia concludes PPAs. NBET receives payments from DISCOs for energy received and pays generation companies for bulk power sent to the grid.	Enter into and execute PPAs with power generating companies and procure new generation capacity on competitive basis, as required.
Transmission Company of Nigeria (TCN)	State entity responsible for the transmission of electricity from power plants to distribution companies, eligible customers and for export. Acts as Transmission Services Provider (TSP), System Operator (SO) and Market Operator (MO). Managed by Manitoba Hydro International of Canada under a three year management contract.	TCN is responsible for grid-connection agreements and may assist in the determination of MW targets for renewable energy

6.2.2 Non-governmental Players

For on-grid renewable energy technologies there are not sufficient national manufacturing facilities in Nigeria. No sole national contractor is currently capable of building a large-scale renewable energy project. At least no local company would be able to handle the development and implementation of a large-scale multi-million US$ project on its own and without support by accomplished international partners. The manufacturing and industry market is working to gain competence and the financial power to implement such projects with the support of international partners and financing institutions.

Some positive examples of companies coming into the market can be given, e.g. a PV module manufacturing facility built by a German company in Sokoto. The facility completed in February 2014 was partly financed by the World Bank, and the plan is to produce solar panels designed to operate in extreme climates. Further to this plant in Sokoto, Karshi Solar Panel Plant (KSPP) with an annual production capacity of 7.5 MWp has been built under the intervention programme of the National Agency for Science and Engineering Infrastructure (NASENI) in Abuja.

Also non-profit organisations have recently become active in the field, especially when it comes to information exchange amongst professionals, lobbying and awareness creation. Amongst them are the Council of Renewable Energy (CREN), (cf. Chapter 4.4), the Nigeria Alternative Energy Association (NAE) and the Association of Nigerian Solar Energy Promoters (ANSEP).

In 2008, the Nigerian and German governments agreed on cooperation in the energy sector. Based on this formal agreement the Nigerian German Energy Partnership (NGEP) was founded. NGEP has been facilitating mainly utility-scale solar IPPs in Northern Nigeria since 2011. The portfolio has since been expanded to include projects of German companies in Nigeria such as investment in conventional and renewable power projects, investment in Nigeria's power grid, gas gathering projects, as well as know-how and technology transfer. [44]

6.2.3 Foreign Development Cooperation Organisations

Most of the major international institutions currently active in the general field of energy in Nigeria are active in one way or another in the field of renewable energy. Clean and efficient modern energy services are the cornerstone of sustainable development, economic activity and poverty reduction. International and national donors and organisations' initiatives and programmes contribute significantly towards raising awareness of the increased role of renewable energy sources in the global energy supply.

The major bilateral implementing agencies with a local office in Nigeria are:

- Agence Française de Développement (AFD), French development cooperation agency
- Department for International Development (DFID), British development cooperation organisation
- Gesellschaft für Internationale Zusammenarbeit (GIZ), German Agency for International Cooperation
- Japan International Cooperation Agency (JICA), Japanese development cooperation organisation
- The Norwegian Agency for Development Cooperation (NORAD), Norwegian development cooperation
- United States Agency for International Development (USAID), US development cooperation organisation

The main development banks active in Nigeria are:

- African Development Bank (AfDB); Côte d'Ivoire
- International Finance Corporation (IFC), USA
- Islamic Development Bank (IsDB), Kingdom of Saudi Arabia
- Kreditanstalt für Wiederaufbau (KfW), Germany
- World Bank (WB), USA

Last but not least the following UN Organisations have an office in Nigeria:

- United Nations Development Programme (UNDP), USA
- United Nations Industrial Development Organisation (UNIDO), Austria
- United Nations Office for Project Services (UNOPS), Denmark

6.2.4 Key Players in Research, Capacity Development and Training

Several pilot projects, surveys and studies have been undertaken under the supervision of the ECN, which has registered five energy research centres. Centres dedicated to renewable energy and energy efficiency include:

- National Centre for Energy Research and Development (NCERD), at the University of Nigeria, Nsukka (responsible for research in solar and renewable energy)
- Sokoto Energy Research Centre (SERC), at Usmanu Danfodiyo University, Sokoto (also responsible for research in solar and renewable energy)
- National Centre for Hydropower Research and Development (NCHRD) at the University of Ilorin (responsible for research in hydropower).

The National Agency for Science and Engineering Infrastructure (NASENI) advises the science and engineering community and SMEs to take advantage of the facilities available to fast-track their manufacturing processes and upgrade their Research and Development (R&D) knowledge.

In terms of capacity development and training, GIZ through its European Union and German Government funded Nigerian Energy Support Programme is currently in the process to develop six clean energy training courses (renewable energy project design, solar PV installation, hydro power civil works, energy auditing, energy management and energy efficient building design) for professionals ranging from unskilled workforce over technicians to specialized engineers.

The courses will are being developed in cooperation with and will eventually be hosted by the following training institutions which already by now possess a certain experience in clean energy technology training:

- Centre for Renewable Energy Technology, Federal University of Technology Akure
- Sokoto Energy Research Centre (SERC), University of Sokoto
- National Centre for Energy Efficiency & Conservation (NCEEC), University of Lagos
- National Power Training Institute of Nigeria (NAPTIN), Kainji
- Centre for Renewable Energy Research, Umaru Musa Yar'adua University, Katsina
- National Centre for Energy Research & Development (NCERD), University of Nigeria, Nsukka
- BAS Consulting, Lagos

6.3 Renewable Energy Policies and Regulations

On overview of policies, acts and regulations has been provided in Chapter 5.4. This sections provides further details on aspects within the documents which are of particular relevance for renewable energy.

The following documents contain the guiding policy statements for renewable energy:

- Renewable Energy Policy Guidelines, 2006, see Chapter 5.4.5
- Renewable Energy Master Plan (REMP). 2012, summary in Chapter 5.4.10
- National Renewable Energy and Energy Efficiency Policy (NREEEP), 2015, see Chapter 5.4.11 and expansion targets in Annex 4

The **Renewable Energy Master Plan (REMP)** sets out in the short, medium and long term what the national energy supply mix should be and articulates the strategic approach and measures to meet the targets. There is therefore a roadmap for implementing government's commitment to create the necessary enabling environment for sustainable energy supply for national development with active participation of the private sector. It is divided into different programmes with targets, timelines and activities. Incentives to promote the attainment of the programmes as well as generally grow the renewable energy market are also provided. However, the roadmap still has to be approved by the National Assembly to be passed into law.

In May 2015, the **National Renewable Energy and Energy Efficiency Policy (NREEEP)** was approved by the Federal Executive Council (cf. Chapter 5.4.11). This new policy will presumably replace the REMP. NREEP targets for power generation using biomass, wind, solar and hydropower as well as renewable electricity overall supply projections are listed in Annex 4.

The NREEEP recognises the importance of renewable energy for both on-grid and off-grid systems. The document points out that energy use in the nation is far from efficient at all levels, i.e. household, industry, and transport.

As per its objectives, the NREEEP declares that the proportion of Nigeria's electricity generated from renewable energy sources shall increase to a level that meets or exceeds the ECOWAS regional policy targets for renewable electricity generation and energy efficiency for 2020 and beyond. An overview of the renewable energy targets (based on 7% growth scenario) is presented in Table 6 – 6[22]; for a more detailed breakdown of the targets see also Annex 4, Tables A – 12, 13 and 14.

TABLE 6 – 6:
NREEEP: SUMMARY OF RENEWABLE ELECTRICITY TARGETS

S/N	Resource[55]	2012 [MW]	Short Term (2015) [MW]	Medium Term (2020) [MW]	Long Term (2030) [MW]
1	Hydro (LHP)	1,938.00	2,121.00	4,549.00	4,626.96
2	Hydro (SHP)	60.18	140.00	1,607.22	8,173.81
3	Solar	15.00	117.00	1,343.17	6,830.97
4	Biomass	–	55.00	631.41	3,211.14
5	Wind	10.00	50.00	57.40	291.92
All renewables plus LHP		(1,985.18) 2,023.18	(2,438.00) 2,483.00	8,188.20	23,134.80
All energy resources (on-grid power plus 12,500MW of self-generated power)		21,200**	24,380**	45,490**	115,674**
% of renewables incl. LHP		(23%)	10%	18%	20%
% renewable energy excl. LHP		0.80%	1.30%	8%	16%

* NREEEP classifies Hydropower as follows:
Pico Hydropower: Pico ←100 kW
Micro Hydropower: 100 kW ↖ Micro ←500 kW
Mini Hydropower: 500 kW ↖ Mini ←1 MW
Small Hydropower (SHP): 1 MW ↖ Small ← 30 MW
Medium Hydropower: 30 MW ↖ Medium ← 100 MW
Large Hydropower (LHP): Large → 100 MW

** The projection for "all energy resources (on-grid power plus 12,500 MW of self-generated power)" is based on the addition of on-grid power, and a base capacity of 12,500 MW of self-generation (i.e. power generated for own use) including off-grid generation from year 2012 to 2030.
Source: [FMP; March 2014]

[22] The figures shown in the table are original figures from the source. Figures in *(red)* are obviously arithmetically wrong.

The emphasis is on delivery of a substantial mega-wattage volume and seems ambitious compared to the current generation capacity. The targeted percentage in renewable energy by NREEEP shall be understood as tentative, as (in view of high cost of renewable energy power plants) NERC has for the next five years set a cap on energy from renewable sources at 10% of total energy sent out. The cap may be subject to review whenever the federal government's policy on energy mix is established.

There are two areas of crucial regulations for on-grid renewable energy projects. The first covers submission of a dossier to NERC to obtain a license for a renewable energy IPP (cf. Chapter 6.5.1). Here the same rules are valid as they are for conventional independent power projects, even if the PPAs are remarkably different. For example, while the conventional PPAs require an analysis of feedstock prices, this does not apply to renewable energy.

The second relates to grid access and requirements: namely the grid code and potential injection points (cf. Chapter 5.5.1). These are decided by NERC in consultation with TCN. The grid code is a regulatory document initiated by the NERC as mandated in the EPSR Act 2005. It outlines the day-to-day operating procedures and principles governing the development, maintenance and operation of an effective, well-coordinated and economic transmission system for the electricity sector of Nigeria [34]. As noted in the document, the grid code is designed to facilitate an efficient production and supply of electricity for all users of the Transmission System and TCN itself without any act of discrimination between users or class of users; and facilitate competition in the generation and supply of electricity in the country. The scope of the grid codes (transmission and distribution codes) applies to power stations connected to the transmission and distribution system. The grid code thus covers the ability of an IPP to connect to the national grid without jeopardizing the latter's stability. As a matter of fact, renewable energy aspects are currently being included in the code in line with international best practice.[23]

6.4 Renewable Energy Support Mechanisms, existing and planned

IPPs relying on renewable energy can expect to face the same difficulties as their larger conventional "sisters": The lack of coherence in the regulatory regime as will be outlined below in the discussion of PPAs. The key hurdles in the transition to a fully operational market are the guarantees NBET and by extension the DISCOs shall provide. In the absence of a firm metering system there are fears that DISCOs may not be able to recoup their costs, and thus they will find themselves unable to pay the IPPs the tariffs they have committed to. To date, only one privately-financed large gas thermal IPP has been finalised, with market players no doubt waiting to see how the interim market evolves. While power purchasing agreements for gas-fired power stations are a highly complex undertaking (especially given the difficulties of indexing of gas prices), this will not apply to renewable PPAs, where the feedstock is steady and has no price.

6.4.1 Financing from Development and Private Banks

With regards to financing opportunities, international Development Finance Institution's (DFI)[24] financing is available to a certain extent for utility scale projects that meet the respective criteria as is indicated by some of the projects in the licence approval pipeline. However, until now none of the utility-scale pipeline projects have actually secured DFI financing.

Local semi-commercial finance institutions like The Bank of Industry and The Infrastructure Bank have expressed interest, however wish to act mainly as 'financial arrangers', meaning they will not provide debt.

On the private financing side, various commercial banks have indicated a willingness to become involved in renewable energy financing. These may provide debt, but at 15% interest rate upwards, which makes the return on investment the project would need to generate too high.

[23] GIZ NESP programme
[24] A development finance institution (DFI) is an alternative financial institution which includes microfinance institutions, community development financial institution and revolving loan funds.

None of the banks in question is currently providing seed financing to cover the development costs for utility scale projects, which has prevented many investors getting off the ground.

6.4.2 Tax Incentives

The Nigerian Government has put in place a number of investment incentives for the stimulation of private sector investment from within and outside the country. While some of these incentives cover all sectors, others are limited to some specific sectors. The nature and application of these incentives have been considerably simplified. "Pioneer Projects" is one these incentive schemes [42]. It grants tax holidays to qualified or (eligible) industries anywhere in the Federation and seven-year tax holiday in respect of industries located in economically disadvantaged local government area of the Federation.

At the moment, there is a list of 71 approved industries declared pioneer industries, which can benefit from tax holiday. The Government encourages investors in the following industries related to renewable energy with tax holiday of 5 – 7 years, which may be granted to:

companies that manufacture transformers, meters, control panels, switchgears, cable and other electrical related equipment, which are considered pioneer products/industries and manufacturers of solar-energy-powered equipment and appliances biomass, large scale mechanised farming (wheat, maize, rice and sorghum) energy efficiency schemes, for manufacturers of oven, cookers, cold rooms, refrigerators, fridges, freezers, air conditioner utility services (independent power generation utilising gas, coal and renewable energy sources).

6.4.3 Current Financial Support Mechanisms – Combination of Unsolicited Bids and Feed-In Tariff Guidelines

Potential suppliers of electricity from renewable energies can apply to the NBET's Unsolicited Power Programme. If a project is approved, at maximum feed-in tariffs set by MYTO II are paid to the producer, Table 6 – 7 shows the FIT for hydro, wind, solar and biomass plants.

The application under the NBET's unsolicited power programme follows six steps until a PPA is effective. Before negotiations between the applicant and NBET begin (step 1) a list of information needs to be provided, including property and evacuation information on the project site, a complete environmental impact assessment as well as project, partner and licence/permit information. In the steps 2 – 4 details on the PPA are negotiated, an application for a power generation license is initiated and information on the financial model as well as an energy yield report need to be presented. In step 5 the developer is required to initiate three tender processes for 1) engineering, procurement and construction, 2) long term services and 3) operation and maintenance. If both parties agree on the terms in the PPA, the tariffs and the tender processes are executed, the PPA can be enforced.

The costs for studies and an estimated 18 months minimum to complete the process are an obstacle for companies pursuing renewable energy projects. So far no PPA has been concluded by NBET for either a small hydropower, a wind power, a solar PV or a concentrated solar power plant. This lack in experience on both sides, applicant as well as NBET, sets another hurdle to investors. In the absence of a PPA template, prospective investors do not yet know in what sort of a financing model they can be active under.

Furthermore, the payment for electricity from renewable energies does not guarantee a positive environment for investments. The maximum feed-in tariffs specified in Table 6 – 7 are advantageous, even by international comparison. However, due to the high tariffs especially for solar power plants, NBET has never accepted the full PV tariff and also said it will not do so in future.

To date, the feed-in tariffs laid down in MYTO II do not give priority access to electricity for renewable energies.

There is no compensation for electricity that is produced but cannot be sold.

As all DISCOs have been privatised, it can be assumed that retail prices for embedded generation (connection to distribution network) will be negotiated between the generation company and the DISCO directly. The MYTO does not apply in this case.

6.5 From Project to Realisation: Renewable IPPs – The Current Process

Any generation company with plans to sell electricity to the national grid or to DISCOs will need to apply for a generation licence with NERC as well as for a Power Purchase Agreement with NBET. The current process, which takes at least one year, is detailed below. A more streamlined process can be expected once proper support mechanisms (FIT for small-scale and competitive procurement for large renewable energy plants, see previous Chapter) have been introduced.

TABLE 6 – 7:
MYTO II FEED-IN TARIFFS - WHOLESALE CONTRACT PRICES (N/MWH)

	2012	2013	2014	2015	2016
Hydropower plants, small up to 30 MW	23,561	25,433	27,456	29,643	32,006
Land-mounted wind power plants	24,543	26,512	28,641	30,943	33,433
Solar PV plants, ground mounted, fixed	67,917	73,300	79,116	85,401	92,192
Biomass power plants	27,426	29,623	32,000	34,572	37,357

6.4.4 Planned Financial Support Mechanisms

For projects with a capacity of larger than 10 MW, a competitive procurement system is under development. Following international best practice examples such as e.g. in South Africa, the Nigerian government is in the process of establishing a competitive procurement system for renewable energy plants larger than 10 MW. Based on technology-specific MW-targets and ceiling tariffs, private companies will be invited to participate in a bidding process with the following process steps: 1) non-binding request for information (RFI), 2) binding expression of interest (EoI), 3) request for proposal (RFP). Successful bidders will obtain a long-term PPA with a fixed tariff as per the submitted proposal. This system is built on the Regulations on the Procurement of Generation Capacity (2014), which make a competitive procurement process for power plants larger than 10 MW mandatory. Details of the process will be elaborated in the second half of 2015. The RFI is scheduled for the fourth quarter of 2015.

Complementary to the utility-scale bidding system, discussions are ongoing to establish a feed-in tariff mechanism for small renewable energies based on the current

6.5.1 NERC - Generation Licence

All IPPs (as well as other generation companies) need a license from NERC to operate in Nigeria. NERC rules dated February 2014 apply for both renewable and non-renewable IPPs as regulated under "Regulations for the Procurement of Generation Capacity 2014". The rules apply only to new projects with more than 10 MW capacity and do not apply to off-grid island applications.

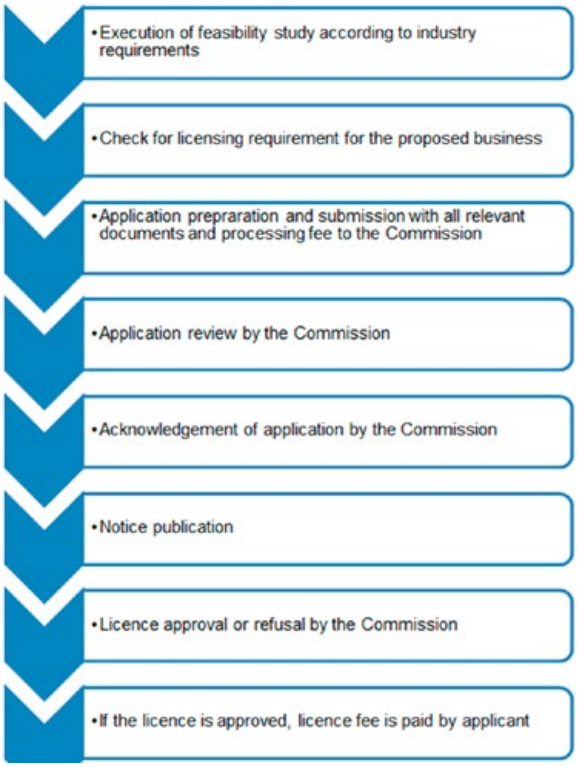
NERC requires the IPP to submit the following documentation as part of the license and tariff approval process:

1. Completed application form
2. Certificate of Incorporation and Memorandum and Articles of Association, or Deed of Partnership, or Deed of Trust

3. Registered title deed to site, or sale agreement, or deed of assignment/gift, or evidence of submission of a title deed to a relevant land processing agency
4. Tax clearance certificate for immediate past three (3) years
5. Certified audited financial statements and accounts for immediate past three (3) years
6. Detailed CVs of managerial and technical staff of the proposed power plant
7. Location map
8. Single line diagram
9. Power plant design
10. Site plan drawings
11. Ten-year business plan
12. Off-take agreement or arrangement
13. Environmental Impact Assessment (EIA) Approval Certificate, or proof of submission and acceptance for processing of the Report on EIA to the Ministry of Environment, Housing & Urban or Planning,
14. Fuel supply agreement, or a letter from a fuel supplier and transporter indicating the inclusion of the fuel needs of the applicant in the supply plans of the fuel supplier and transporter
15. Agreement with/approval from Ministry of Water Resources (if applicable)
16. Letter of Intent or a MoU from EPC contractor
17. MoU or Letter of Intent from the technical partner
18. Evidence of confirmation from Transmission Company of Nigeria and proposed connection point has capacity to accept the proposed load.
19. Financing agreements or letter to fund the project from bank(s)
20. Power plant commissioning schedule

Once documents have been submitted, the process takes the following path, as described in Figure 6 – 5.

FIGURE 6 – 5:
RENEWABLE ENERGY LICENSING PROCESS



Source: GOPA-International Energy Consultants GmbH

6.5.2 NBET - Power Purchase Agreement

Under the unsolicited bidding process any generation licence must be complemented by a power purchase agreement (PPA). The Nigerian Bulk Electricity Trading Company (NBET) has the central, yet temporary, role in the economic procurement of new generating capacity during the transitional market stage. On this basis, the IPPs will have to negotiate an individual PPA for their project with NBET.

NBET requires four mandatory submissions from IPP developers prior to initiating a PPA approval process as detailed below:

1. Land documents:
   - Registered title deed for the project site from Land Registry or
   - Notarised sale agreement of the project site land or
   - Deed of assignment / gift of the project site land or
   - Evidence of submission of a title deed to a relevant land processing agency regarding the project site land.

2. Environmental & Social Assessments [25]
   An Environmental Impact Assessment (EIA) that meets the Federal Ministry of Environment standards has to be completed. NBET expects to receive the final and complete EIA for the project and also the approval from the Federal Ministry of Environment.

3. Transmission line connection agreement [26]
   A comprehensive load flow study at the project site must be completed and the project must get a provisional approval from the Transmission Company of Nigeria (TCN). This will provide NBET the comfort that there will be no stranded generation capacity.

   Interested IPP developers must conduct a power flow study to confirm that all generated power can be delivered to the national transmission grid without creating any technical issues. Upon request, TCN supplies the IPP developer with the necessary grid input data for completion of this analysis.

   Typically an IPP developer has to define costs, equipment specifications, engineering design specifications to connect to the grid for its internal planning and cost estimate purposes. Presently TCN does not have a standard application package for interested IPP developers.

   Power-flow or load-flow studies are important for planning future expansion of power systems as well as in determining the best operation of existing systems. The main information obtained from the power flow study is the magnitude and phase angle of the voltage at each bus and the real and reactive power flowing in each line.

4. Energy source/ fuel supply study
   For all renewable generation, NBET requires to see the resource availability reports and completed studies.

Additional NBET due diligence includes review of:

- Project partners, sponsors, technical and financial partners
- Status of other required permits
- Project information, capacity, technology, construction schedule, etc.

6.5.3 Embedded Generation

Based on the "Regulations for the Procurement of Generation Capacity 2014" embedded generation means the generation of electricity that is directly connected to and evacuated through a distribution system which is connected to a transmission network operated by the licensee vested with system operations functions (cf. Chapter 5.5.4) [NERC; Jan 2012]. Equally as in the other regulations, an embedded generation system is a generator directly connected to and evacuated through the distribution grid. Most small and mid-sized renewable energy systems are very likely to be connected directly to the distribution

[25] The Federal Ministry of Environment, Environmental Impact Assessment (EIA) Division is responsible for implementing the EIA Act No. 86 of 1992 with the mandate to register new projects, verify sites, screening/scoping of projects. As regards the negotiation for PPA with NBET, FMENV shall review and approve the site-specific EIA.

[26] NBET requires a copy of TCN approved load flow study as part of the PPA application package.

grid, either due to the voltage level or driven by the location and connection costs.

The NERC procurement rules dated February, 2014 state:

1. Generation capacity up to 10 MW is exempt from the February 2014 published rules
2. Various existing arrangements and applications are also exempt from the new rules
3. For addition of any generation capacity over 10 MW a competitive bid is required
4. There are two methods for DISCOS to obtain additional embedded generation;
   a. Request NERC to facilitate a competitive bid procurement or
   b. Individual DISCO to initiate a competitive bid procurement

End-user tariff(s) shall be negotiated between the embedded generation provider and the eligible customers and shall be fixed for a specified period. Tariffs are subject to periodic reviews and approval by NERC.

6.5.4 Challenges

Before a project gets to the licence submission stage, a large quantity of studies need to be completed, meaning that the company or investor 'developing' the project must be prepared to incur substantial costs ahead of licence approval in the hope to gain such.

Investors, international financing institutions and funds may not want to engage in such an expensive project development and make any real commitments until they have a license and PPA Letter of Intent in place.

To date, a large number of such licences have been granted, for both on- and off-grid independent power producers (IPPs). However, the number of the projects that have since progressed to financial close and are buttressed by PPAs is limited (in case of renewable energy there is none), suggesting that licenses were obtained as negotiating chips for future sale rather than with the firm commitment to build and operate a power plant.

6.6 Conclusions: Renewable Energy Market and Potential

Nigeria has immense potential and opportunities for a large-scale roll-out of utility-scale renewable power plants, specifically biomass-to-power, waste-to-power, solar PV projects and small and medium-sized hydropower stations (on-grid). The viability of wind as a primary energy source would need further investigation.

For on-grid renewable energy technologies, the manufacturing and industry market in Nigeria is on its step to gain competence and financial strength for implementation of large-scale projects with the support of international partners and financing institutions. Several joint ventures of international and national corporations and financial institutions are currently engaged in for instance utility-scale solar IPP projects that are either in the licence application stage or in solar panel fabrication and installation stage. There are however no sufficient national manufacturing facilities in Nigeria; only some local production of PV modules is done.

Planned projects

To date, no real commercial large-scale project has been successfully implemented, other than hydropower (and small biomass, e.g. ethanol production). Stakeholders and key players all have programmes to support and implement various renewable energy technology projects in the near future. The FMP for instance has awarded contracts to Nigerian consultants to undertake "consultancy services for wind, solar and biomass projects in different locations nationwide"; results are outstanding. FMP in cooperation with the FMWR will construct at least 16 large, medium and small hydropower plants, increasing the country's power generation capacity by about 4,000

MW. Private investors and developers have licensed various projects with NERC already. However, none of these projects has yet been completed.

Renewable energy policy and strategy targets
Good foundations in formulating the renewable energy policy and strategies have been made. In 2015, the National Policy on Renewable Energy and Energy Efficiency (NREEEP) has been approved. However, the lack of a structured support mechanism, the variety of actors with partly overlapping mandates and unclear authorisation processes pose significant hurdles to project developers.

Support mechanism
Various commercial banks indicate a willingness to become involved in RE financing, such as the Bank of Industry (BoI) and The Infrastructure Bank (TIB). Nigerian banks aim to act merely as "financial arranger", i.e. without providing own seed financing and/or at high interest rates (15% upwards). The current National Renewable Energy and Energy Efficiency Policy supports the introduction of financial incentives; but this still needs to be operationalised.

The MYTO 2.1, as the framework for determining the industry pricing structure, is potentially advantageous for foreign investors. Though, this certainly requires factoring in country risks, logistics, the blurred ministerial responsibilities as regards the applications processes for tax relief and customs exemption. In addition, quality monitoring still needs to be put in place as well as benchmarking to international best practises. From this perspective, Nigeria appears to be a comparatively unregulated market for renewable energy at the moment.

Currently, negotiations on the basis of the MYTO 2.1, have to be conducted individually between the IPP license-holder (the power generator) and the buyer (to date NBET) to obtain a power purchase agreement.

A coherent support mechanism, as e.g. mentioned in Chapter 6.4, is crucial in order to attract first-class reliable generation companies. Otherwise it may be to the detriment of consumers as it may encourage the introduction of sub-standard facilities that are not in any way sustainable.

Project realisation, opportunities and challenges
Before a project gets to the licence submission stage, several studies need to be completed ahead of license approval. A company or investor 'developing' the project must hence be prepared to incur costs for these studies.

In practice, anyone looking to obtain a generation licence from NERC is required to obtain a PPA Letter of Intent ("LOI") from NBET (or from a distribution company for embedded generation), prior to being licensed. The NBET, on the other hand, wants to see funding commitments prior to the LOI.

Energy Efficiency simply means using less energy to produce the same service. When dealing with the energy sector, great care must be taken not to mistake energy efficiency for energy conservation which simply means reducing or going without a service to save energy. For example, turning off a light is energy conservation but replacing an incandescent lamp with a compact fluorescent lamp (energy saving bulb which uses less energy to produce the same amount of light) is a measure of energy efficiency. However, both energy conservation and energy efficiency reduce greenhouse gas (GHG) emissions.

7.1 Energy Efficiency Market

The main factors driving energy efficiency are savings realised from a reduced need for investment in infrastructure (economy level) or savings on fuel expenses (individual entity level) as well as the mitigation of environmental effects and climate change (global level) by reduction of GHG emissions.

Any cost-related decision concerning energy efficiency, at the individual level, is based on a trade-off between an immediate cost and a future decrease in energy expenses expected from increased efficiency. The higher the energy price, observed or expected, the more attractive energy efficiency becomes. Despite the fact that the key focus in the energy sector in Nigeria today is on improving power generation, there is need to formulate and implement energy efficiency programs in the various sectors of the economy. This will contribute not only to reducing the power shortage, but will also increase the competitiveness of the industrial sector through the reduction of energy intensity[27] per unit product. Moreover, reduced energy costs would also give policymakers greater latitude for reducing electricity subsidies and freeing up the national budget. Last but not least, reducing energy use by enhancing efficiency is one method of cutting carbon dioxide emissions and mitigating climate change.

There are two levels at which energy efficiency potentials can be exploited. The one level is the way energy is generated, transmitted and distributed; the second is the way energy is consumed in the various sectors of the economy (e.g. transportation, buildings, and industries).

Table 7 – 1 shows an excerpt of the energy efficiency indicators gathered by the World Energy Council for the years 2010 and 2011. The database gathers the information on a very high level and may contain some gaps due to missing information but it serves as an indicator for the trend in energy efficiency.

The potential for investment in energy efficiency by manufacturers/vendors (profiting from machinery/appliance substitution) shown in Table 7 – 1 and 7 – 2 is vast. The scope for institutions supporting rural and lower-income households in reducing their energy consumption is likewise large, as already observed with regard to stoves and fuel wood consumption [CREDC; 2008].

The table shows remarkable energy efficiency gains that have been made in industry over the 11 years covered, and also reveals that CO2 emissions per capita have noticeably fallen over the 11 year period presented in the table. The population has grown significantly and "final energy intensity at 2005 GDP structure" has risen. Both are areas where there is further market potential. Moreover, the table clearly indicates that there is an efficiency shortfall in the energy generation sector, highlighting the extent of distribution/transmission losses and the problems with the fleet of thermal power stations.[28]

Despite the efficiency gains over the 11 year period shown above, Table 7 – 2 in Chapter 7.3 also points to significant further saving potential since Nigeria's energy intensity measured as energy consumption per unit of GDP is approx. 40% higher than peer countries like Brazil, Indonesia and Bangladesh.

[27] Energy Intensity is a measurement of energy conservation, the amount of energy consumption per unit (here GDP). It expresses the consumer behaviour in energy saving or changes in the industrial sector as an average figure for the whole country

[28] As a side note: It can already be observed with this well curated data set that the establishment of a consistent data on energy efficiency is a difficult tasks since it depends on available data and a common method or definition on how to measure efficiency, losses and emissions. This can be exemplified with the rate of electricity transmission-distribution losses that jump over the years: 39.7 (1990), 39.3 (2000), 24.4 (2005), 6.04 (2009), 17.7 (2010), 17.7 (2011). The jumps in the series may be caused by the extension of the data gathering to other parts of the system or change of methodology

TABLE 7 – 1:
ENERGY EFFICIENCY AND CO_2 INDICATORS FOR NIGERIA

	Unit	2000	2011*	2000-11 (%/year)*
Key indicators				
Primary energy intensity (at purchasing power parities (ppp)	koe/$05p	0.498	0.319	-4.0
Primary energy intensity excluding traditional fuels (ppp)	koe/$05p	0.090	0.052	-4.9
Final energy intensity (at ppp)	koe/$05p	0.457	0.292	-4.0
Final energy intensity at 2005 GDP structure (ppp) [2]	koe/$05p	0.287	0.556	6.8*
CO2 intensity (at ppp) [1]	k CO2/$05p	0.227	0.130	-4.9
CO2 emissions per capita [1]	t CO2/cap	0.333	0.291	-1.2
Industry				
Energy intensity of industry (to value added at ppp)	koe/$05p	0.167	0.152	-0.9
Energy intensity of manufacturing (at ppp)	koe/$05p	0.857	0.781	-0.8
Share of electric process in steel production	%	100	100	0.0
CO2 intensity of industry (to value added at ppp) [1]	k CO2/$05p	n.a.	0.058	n.a.
Households				
Average electricity consumption of households per capita	kWh/cap	35.8	80.2	7.6
Average electricity consumption of electrified households	kWh/hh	399	604	3.8
Services				
Electricity intensity of service sector (to value added at ppp)	kWh/k$05p	38.1	44.1	1.3
CO2 intensity of service sector (to value added at ppp) [1]	k CO2/$05p	n.a.	0.037	n.a.
Transformation sector				
Efficiency of total electricity generation	%	48.8	45.3	-0.7
Rate of electricity transmission-distribution losses	%	39.3	17.7	-7.0
Efficiency of thermal power plants	%	37.0	39.7	0.6
Share of renewables in gross electricity consumption	%	38.2	20.7	-5.4

[1] CO2 from fuel combustion – [2] by main sector – * data of 2010 if 2011 data not available
Source: ENERDATA Information Services, [7], units: koe = kilogram oil equivalent, $05p = US$ basis 2005

7.1.1 Existing Energy Efficiency Projects

With the exception of the UNDP/ECN programme described below, measures in the sense of centrally planned or coordinated programmes are not yet in place, although some policies exist through ECN, the National Centre for Energy Efficiency and Conservation (NCEEC) and FMENV. That said, the National Centre for Energy Efficiency and Conservation (NCEEC) attached to the University of Lagos has been conducting research into energy efficiency and conservation and under this mandate has conducted studies into the promotion of energy efficient appliances and light bulbs (cf. Chapter 7.4 for details on the organisation). The insights have not yet been fed into tangible measures.

The Energy Commission of Nigeria (ECN) in partnership with the Cuban government and with support from ECOWAS has been distributing 1 million Compact Fluorescent Lamps (CFL) in Nigeria free to residents in organised estates across the country.

Under the aegis of Federal Ministry of Environment's National Clean Cooking Scheme (NCCS) run by the Renewable Energy Programme Unit, the Rural Women

Energy Security (RUWES) has started production and distribution nationwide of a purpose designed bio-fuel stove in partnership with pot-makers Tower and energy firm Envirofit.[29]

The Rural Energy Access Project (REAP) was initiated by the Federal Ministry of Environment's Renewable Energy Programme Unit to address the need to source and deploy alternative and sustainable sources for lighting purposes, whereby energy efficiency spells empowerment as it brings light to the rural poor who suffer most from a dearth of electricity. REAP hinges on reducing power consumption by using clean, energy efficient LED bulbs (light-emitting diode) and introducing household stand-alone solar kits to replace incandescent bulbs, single-wick kerosene and oil lamps as well as small diesel generators.

Julius Berger of Nigeria introduces energy efficient buildings to the country. In 2013, the company completed the office building of the Central Bank of Nigeria in Lagos and has ongoing projects, like the Rose of Sharon Building, Nestoil Towers, and Akwa Ibom Stadium Complex. According to its own presentation, the company has the specialised knowhow needed to construct buildings that meet the Leadership in Energy and Environmental Design (LEED) standards for certification. However, these pilot projects are high-cost measures and cannot be regarded as common practice in the building industry.

The Energy Efficient Housing Scheme is a partnership between the FMENV and Aso Savings And Loans Plc, a leading mortgage bank with the objectives of providing affordable energy efficient housing for staff of the Ministry by micro generation mainly from solar and Bio-energy. The project was recently launched in Kaduna with the prospect of containing 2000 housing units and many more are on the pipeline from different states across the nation.

Projects looking at energy efficiency in the industrial sector are not existent so far. To a limited extent, a few industries implemented energy audits. This involves identifying in each state all manufacturing hubs and major areas of industrial production. The estimated energy needs of all industrial manufacturing hubs will be included in Nigeria's energy dispatch considerations, and used in planning the electric power sector. [NIRP; 2014]

The project "Promote Energy Efficiency in Nigeria's Residential and Public Sectors" (2011 – 2015) aims to introduce energy efficiency policies and measures, including standards and labels for refrigerators and lights in Nigeria. Managed by the UNDP, the project is being implemented by an Energy Efficiency Unit, which has its head office on the premises of the Energy Commission of Nigeria. It is going to receive financing in the amount of approximately USD 4.8 million for a period of 5 years. [79]

7.1.2 Planned Energy Efficiency Projects

The Abuja Green City: The Abuja Green City is an initiative of the Renewable Energy Programme of the Federal Ministry of Environment, together with Green Carbon Afrique Creation Environmental Services and Integra Integrated Renewable Energy Services. The low-carbon development is using a combination of local electricity generation, improved insulation, and energy efficient devices for the apartments.

Abuja Centenary City: Being planned by an investor from the Gulf and designed by Julius Berger International, this city will feature an array of sustainable energy measures. [Primetech AS&P; 2014]

With support from the Global Alliance for Clean Cookstoves, the International Centre for Energy, Environment and Development (ICEED) is establishing the Nigerian Clean Cookstoves Design and Testing Centre at Afikpo, Ebonyi State. The centre will provide stove producers and users, and other relevant stakeholders the opportunity to confidently compare stove performance and safety. In addition, it will provide a common set of terminology for wood stoves for easier understanding and

[29] See also the "Save80 Stoves: Promoting Energy End-Use Efficiency for Sustainable Development" project launched in 2011. The „Efficient Wood Fuel Stoves for Nigeria Programme" is a joint initiative of the German NGOs, Atmosfair GmbH and Lernen - Helfen - Leben e.V. (LHL) and a Nigerian NGO, Developmental Association for Renewable Energies (DARE) to promote dissemination of improved cooking stoves to households in Nigeria. This project has been registered as a CDM project and is being financed by a Carbon offset company Atmosfair GmbH.

communication; give stove producers, marketers and users assurance of product quality.

The Nigerian Clean Energy Access Programme – NCEAP: In line with the quest to reduce the global impact of climate change and as part of the solution to the epileptic power supply in Nigeria through NCEAP plans to distribute 150 million bulbs over the next five years under the Clean Development Mechanism (CDM). This is part of FMENV's initiative to ensure energy efficiency is private sector driven.

GIZ – Nigerian Energy Support Programme: The European Union and German Government funded Nigerian Energy Support Programme (NESP) in cooperation with the FMP, the FMLHUD and the FMITI focuses on energy efficiency in the building and industrial sector. Pilot projects will be implemented for apartment buildings, for the application of solar water heaters and with regard to energy management systems in selected industries. Experiences are used for up-scaling into policy development and the development of support mechanisms such as financing schemes, introduction of ISO standards and standards and labels for household appliances.

7.2 Energy Efficiency: Power Generation

7.2.1 Efficiency of On-Grid Generation, Transmission and Distribution

The technical efficiency in the electricity sub-sector is determined by efficiency of the generators used in the system as well as losses in the transmission and distribution.

According to the data on the efficiency of thermal power plants in Nigeria provided by the World Energy Council, the electricity generation efficiency is with an average of 38.3% even slightly above the mean values of similar economies (e.g. India: 28.6%, Indonesia: 34.6%, South Africa: 35.7%). It is not clear what was considered when generating these values and also no information on existing environmental measures such as reduction of noise or emission is provided.

The fleet of power plants producing base-load capacity in Nigeria consist of gas turbine power plants in open-cycle configuration. The efficiency of such power plants is limited by physical laws (Carnot process). Nigeria's overall efficiency in base-load could be increased by changing the technology, for example to combined cycle power plants (CCPP) or combined heat and power (CHP) technology. In some cases these more efficient technologies have already been introduced, for example at Afam VI, Alaoji, Okpai and Olorunshogo power stations.

On the other hand, technical losses in power transmission and distribution are as high as 17 – 20% [30] (cf. Chapter 3.9). The potential to increase the stability of power transmission and to reduce losses is enormous. Since the privatisation of the DISCOs, the issue will be pursued from the economic point of view. The companies will make efforts to increase their sales by minimising their system losses.

7.2.2 Genset-Based Generation

The absence of on-grid energy supplies or unreliable power supply from the grid has led consumers from all categories to install their own generation and even distribution equipment. The majority of these generators use diesel or petrol as fuel. Replacing old diesel generators with at least newer more efficient generators can increase the reliability of the electricity supply and reduce energy costs. Empirical evidence suggests that over a 30 year life-span a generator's output falls by half. Accordingly, in the medium to long-term the goal must be to replace such generators with renewable energy sources wherever possible.

In 2008 a study from the University of Chicago estimated the life-cycle costs of a diesel genset in Nigeria at US$ 13,160 per kVA installed capacity (12 years lifetime, 8% discount rate) [Kennedy-Darling, J., Hoyt, N., Murao, K., Ross, A.; 2008]. Since then, the prices for genset, diesel

[30] TCN archive (supported by NIAF)

and maintenance has risen and it can be assumed that the life-cycle costs for a diesel genset are much higher today. The gains to be made from efficient generators are therefore immense in absolute terms.

In this context, the Standards Organisation of Nigeria (SON) has the mandate by law to make sure that substandard generators and other industrial goods and spare parts do not come into the country. Reports about substandard generators and parts in shops and markets seem to indicate that the mandate is not fulfilled resulting in unnecessary costs and the waste of energy and resources. Indeed, there is scope also to introduce a LEME (List of Eligible Equipment and Materials) [5], [6]. Energy efficiency measures would reduce the demand for generators or at least demand for their continuous use [GIZ; 2013].

7.3 Energy Efficiency: Consumption

There is a specific parameter to measure the consumption of energy required for a certain product or unit: energy intensity. The energy intensity is the ratio of energy consumption in relation to the reference metric. This is typically the national gross domestic product in the case of a country's energy intensity, or energy consumption per household for sector-specific intensities but it can also be measured in energy used per unit of commercial floor space or another metric indicative of a sector or process.

A peer group comparison of energy use is quite instructive to highlight the situation in Nigeria (cf. Table 7 – 3).

Compared to other countries, Nigeria shows relatively high energy use per unit of GDP expressed in US$ 1,000. This can hardly be influenced by a low price of grid electricity, given that electricity supply from the grid is erratic and that the alternative source is a diesel generator, which as the table shows is comparatively expensive in the country. The low absolute consumption figure is indicative of the lack of generating capacity. However, the high energy use is clearly a point where energy efficiency measures could pay off.

As an example, the 2010/2011 General Housing Survey carried out by the National Bureau of Statistics in Nigeria [NBS; 2010/11], provides data on the distribution of households by type of main lighting fuels. It has been revealed that more households rely on kerosene as the main lighting fuel, followed by electricity, battery/dry cell and firewood respectively. Based on these figures, one can assume that electricity consumption for lighting will increase with households connected to electricity supply.

TABLE 7 – 2:
ENERGY INTENSITY – A PEER-GROUP COMPARISON

	Base year	Nigeria	Indonesia	Bangladesh	South Africa	Brazil
Energy intensity (kg of oil equivalent) per US$ 1,000 GDP (constant 2011 PPP)	2011	137.5	101.6	90.9	231.3	95.9
GDP per unit of energy use (constant 2011 PPP US$ per kg of oil equivalent)	2011	7.3	9.8	11.0	4.3	10.4
Energy use (kg of oil equivalent) per capita	2011	721	857	205	2,741	1,371
Pump price for diesel fuel (US$ per litre)	avg. 2009–2013	1.09	0.47	0.76	1.42	1.02
Consumption by households (in billions of kWh)	2005	7.7	41.18	8.94	36.97	83.19

Source: World Bank, [68]

Figure 3 – 2 in Chapter 3.3 shows quite clearly that with a share of 80% the bulk of energy is consumed in the residential sector. An analysis of the energy saving potentials conducted in 2013 reveals that hot water heating, cooling and lighting have the largest saving potential at household level [GIZ; 2013].

On a more global level, buildings would gain or be more efficient if built according to the climate at the respective location. Specific energy consumption of a building is dependent on the quality of the building as such, the building orientation and the design and material of the building envelope, just to name a few criteria. Unlike with traditional housing, modern architecture and also the clients in the urban areas do not account for bioclimatic construction. As a result, the study also recommends top-level policy changes in the building sector such as development of an energy building code, creation of a design catalogue for affordable energy efficient buildings, introduction of technical and financial support mechanisms, priority for energy efficiency in public procurement as well as awareness raising measures and training and capacity building.

Looking at the end-user side, savings of some 26.8% of the total energy consumed per household can be achieved if solar water heaters are introduced (whereby this does not consider the use of energy to pump the water). Secondly, estimates reveal that the total energy requirement can be reduced by a further 6.7% if the average energy consumed by cooling systems is decreased through shading, insulation, timer switches, etc. Thirdly, the introduction of energy-saving lighting sources will produce net energy savings of around 6% per household. All in all, measures taken in this regard would garner energy consumption reductions of close to 40%.

One of the reasons for inefficient use of energy in Nigeria is the use of old and inefficient equipment and production processes. The other reasons are practices that lead to energy wastage, such as the inefficient traditional three-stone fuel woodstoves used by 70 – 80% of households [NBS; 2010], the use of vehicles with low fuel efficiency (e.g. old vehicle fleets, poor maintenance), the predominant use of incandescent light bulbs, the indiscriminate use of electricity among urban dwellers in Nigeria such as leaving appliance on when not in use, and the purchase of second-hand appliances which have often been rejected by former users in favour of more efficient appliances.

The FMENV's Department of Climate Change outlined how the energy-efficiency potentials offered an option to mitigate the climate change impact of Nigeria's energy system by adoption of the following [FMENV; 2010]:

1. Introduction of compact fluorescent light (CFL) bulbs at a negative incremental cost of $58/ton CO2, with 5.155 m ton CO2 reduction capacity;
2. Introduction of improved kerosene stoves in households, at a cost of $21/ton of CO2 reduced (6.122 m ton CO2 reduction capacity) ;
3. Fuel-oil to natural gas substitution in the cement industry at $18/ton (7.49 m ton CO2 reduction capacity);
4. Improved electrical appliances ($16/ton) and wood-stoves ($3/ton) in the residential sector (9.566 m ton CO2 reduction capacity); and
5. Introduction of efficient motors in industry at $15/ton (10.738 m ton CO2 reduction capacity).

Refrigerators

Table 7 – 3 compares the average electricity consumption of refrigeration appliances in Nigeria with France, England and Sweden, which shows that the average consumption per appliance is as much as double as high (though climatic factors are ignored which certainly would reduce the gap).

TABLE 7 – 3:
ENERGY EFFICIENCY AND KITCHEN COOLING APPLIANCES – A COMPARISON OF AVERAGE ANNUAL CONSUMPTION

(kWh/p.a.)	Fridge	Fridge-freezer	Freezer	Expected impact of energy efficiency measures such as standards and labels
France 2007	253	460	556	36%
Sweden 2007	225	469	470	7%
England 2007	162	427	344.5	38%
Nigeria 2012	420	698	756	n.a.

Source: UNDP newsletter / case study

Air Conditioners

Between 2006 and 2014, a total of 24 million air conditioning units (domestic, commercial and industrial) were imported to Nigeria, the majority for domestic use. The share of air conditioners in a household's electricity consumption is substantial. A GIZ report suggests the Nigerian market is far from saturated and the stock of air conditioners will continue to increase. [GIZ; April 2015]

Solar Water Heaters (SWH)

A recent GIZ study concludes that the associated energy cost savings comparing Solar Water Heaters (SWH) for domestic application with electric heaters are negligible. One reason for this is that the market for SWHs is not yet well developed in Nigeria and hence prices are high. The second reason could be that the electricity tariffs in Nigeria are comparatively low (although rising according to the MYTO 2.1 regulation). The situation is similar in educational institutions and hospitals. Therefore, incentives, grant, and financing models are needed to make SWH attractive for potential users. [GIZ; Dec 2013]

On the other hand, the study also reveals that the use of SWH is profitable in hotels even without subsidies. Results show a theoretical payback period of 3 to 10 years. However, most hotels have decentralised water heating systems that make retrofits with SWH systems more difficult.

Energy Efficiency in the Industrial Sector

The industrial sector is probably the segment of the economy where energy efficiency measures would be easy to identify and to implement. Sustainable energy efficiency measures would show results quickly in the form of higher productivity through overall optimisation of processes and savings in feedstock and energy expenses.

An assessment of the industrial energy sector [GIZ; Mar 2015] confirms that the constant power shortages across the country and the lack of efforts from the government to respond to the energy demand in the industrial sector remain the main barriers to a sustainable industrial development in Nigeria. The survey found that on average 48% of total electricity consumed annually in the manufacturing sector is self-generated by using diesel generators which 86% of Nigerian firms own due to electricity outages. In fact, the total number of outages stood at 197 hours per month, compared to 15 and 39 hours in the world and Sub-Saharan Africa, respectively. In the manufacturing sector, chemicals & pharmaceuticals, metal products and plastics are the top three sub-sectors in terms of concentration of high power-consuming industrial units. They account for about 60% of power consumption in the >100,000 kWh per month category. Lagos area has the maximum concentration of industrial units (71%) consuming over 100,000 kWh per month.

TABLE 7 – 4:
POTENTIAL AREAS OF ENERGY SAVINGS ACROSS INDUSTRIAL SUB-SECTORS

	Food & Beverage	Chemicals/ Pharmaceuticals	Plastics	Metal Products	Automotive	Textiles
Lighting	X	X	X	X	X	X
HVAC	X	X	X	X	X	X
Thermal/Steam	X	X	X	X		X
Electro-Mechanical	X	X	X	X	X	X
Air-Compressors	X	X	X	X	X	
Heat Controllers	X		X	X	X	
Water Pumping	X	X	X	X	X	X

Source: [MAN; 2013]

Table 7 – 4 presents potential areas where energy savings are feasible across these industrial sub-sectors.

Looking more closely at the industrial processes, opportunities comprise the following [GEF-UNDP; 2011]:

- monitoring and eventual retrofit of better electric drives,
- changes in the controlling of fans, blowers and pumps,
- optimised dimensioning and failure safe operation of air compressors,
- optimisation of design and use of heating, ventilating, and air-conditioning operation via maintenance and recirculation,
- improvement of lighting concepts and
- last but not least, behaviour changes which would also optimise the overall manufacturing set-up.

However, inadequately trained personnel and professionals is another factor inhibiting the development of energy efficiency in Nigeria. Out of the 150 respondents interviewed in the study conducted by Community Research and Development Centre (CREDC) in 2009, 77% of them said that no member of their organisations had been trained on energy management.

7.4 Energy Efficiency Stakeholders

The significant obstacle for the broader development and realisation of energy efficiency measures in Nigeria is the lack of a policy framework and regulations to introduce and mandate legal energy efficiency requirements. However, voluntary measures and incentives are also important to support the required changes. A sound mix of both approaches could help to change human behaviour and send the right signals for market transformation.

7.4.1 Public Authorities

With regards to energy efficiency, there is no clear public institution in the lead for coordinating activities. The FMENV has been active within the framework of its climate change programmes and initiatives (see initiatives described in Chapter 4.1.2). As the energy policy maker for the Federal Government, FMP's role as regards energy efficiency has been limited to electricity/power issues which it has not fully addressed. Increased energy efficiency is also linked to NERC's mandate of ensuring that electricity is delivered to customers in a cost-effective and sustainable manner. Other main stakeholders in energy efficiency include the Energy Commission of Nigeria (ECN) and the Standards Organisation of Nigeria (SON).

Within the framework of collaboration with UNDP, the ECN under the FMST are also undertaking impact-oriented initiatives and projects, through research and development in clean energy technologies; the energy efficiency strategy document currently under development by the ECN may however overlap with FMP's mandate, which is why close cooperation is crucial. In maintaining a hierarchical relationship with FMENV, the National Environmental Standards and Regulations Enforcement Agency (NESREA) has remained relatively restrained in activities until recently. The agency has started to take a proactive role in promoting energy efficiency by setting guidelines and standards for energy and ensuring compliance. However, there is need for coordination of NESREA's activities and SON in order to avoid overlap and conflict in mandates.

SON has the mandate to set standards and ensure compliance of all energy-related equipment, something it has started to fulfil by developing standards for certain electric appliances such as lighting and refrigerators. SON has the chair of the technical committee for regional standard development.

Although energy efficiency plays a key role in the built environment and building designs, the activities of FMLHUD have been relatively silent in the past. This is set to change with the building code that is currently being revised by the Ministry and other professional bodies, as well as with FMLHUD's decision to set a positive example by introducing an energy management stem in its main office.

7.4.2 Additional Energy Efficiency Stakeholders

Table 7 – 5 provides an overview of additional stakeholders active in the Nigerian energy efficiency sector.

TABLE 7–5:
LIST OF ADDITIONAL ENERGY EFFICIENCY STAKEHOLDERS

Stakeholder	Mandate	Role in Relation to EE
Department of Climate Change, FMENV	focal agency on matters relating to climate change in Nigeria	Designated national authority responsible for approving Clean Development Mechanism (CDM) projects
National Ozone Office (NOO) and Ozone Project Implementing and Man-agement Unit (OPIAMU), Department of Pollution Control, FMENV	Manages the mandatory phasing out of chlorofluorocarbons (cfc) and hydrochlorofluorocarbons (HCFCs) implemented under the Montreal Protocol.	A positive side effect of the Chlorofluorocarbon CFC phase-out is the impetus to develop and invest in a new generation of energy efficient air-conditioning and refrigeration equipment.
Nigerian Custom Service (NCS)	Government agency charged with the responsibility for controlling all cargo and goods entering, exiting or transiting through Nigerian territory	The agency could help to enforce EE standards for appliances. Over 700 NCS officers and other chemical enforcement officers have been trained by OPIAMU to empower them to eliminate the importation of the CFC-based materials.
Nigerian Association of Refrigeration and Air Conditioning Practitioners (NARAP)	Industry association	Members are strategic partners and most have been trained by OPIAMU and are sensitised to the banning of CFC based appliances. Most of these members will be targeted for training on the benefits of adopting EE appliances.
Manufacturer's Association of Nigeria (MAN)	Represents the manufacturing industry; strong industry network spread over Nigeria with 10 sectors	MAN will continue to be a key partner in incentivising their member companies to apply energy efficiency measures and to introduce energy management systems.
National Centre for Energy Efficiency and Conservation (NCEEC)	Responsible for research in energy efficiency and conservation	Working in close collaboration with SON, NCEEC is a potential centre for establishing an independent testing centre for appliances.
Climate Change Desk of the Federal Ministry of Science and Technology	Consultation forum for desk officers from other parastatals in order to provide links to these parastatals.	The Ministry has set up 11 centres of excellence intended to conduct R&D on RE and other issues related to climate change and also ensures that findings are developed into sustainable commercial projects.
National Association of Chambers of Commerce, Industry, Mines and Agriculture (NACCIMA)	Industry association	NACCIMA members (from the power and industrial sectors) will be critical in the successful promotion and mainstreaming of energy efficiency measures and appliances.
Importer of Electrical Appliances	Commerce	Appliance manufacturers and importers will be critical partners for any labelling programme. Appliance manufacturers, once they have been established locally, will need to ensure proper testing of all new models according to internationally recognised testing procedures.
Community Research and Development Centre (CREDC)	Carries out activities that promote RE and EE in Nigeria.	Works closely with the DCC and other organisations. CREDC published a report of an EE baseline survey in Nigeria. With a high level of expertise in EE and advocacy, CREDC will be instrumental in carrying out public outreaches and training of professional. [CREDC; 2009]
IPP owners, DISCOs, TCN	Principle power sector players	Given the severe generation, transmission and distribution losses, these corporations and TCN stand to gain substantially from more energy efficient measures.

7.4.3 International Organisations

An increasing number of international organisations are already active or planning to get involved in supporting the energy efficiency sector in Nigeria.

The EU and German Government funded Nigerian Energy Support Programme of GIZ in cooperation with the FMP, FMLHUD and the FMITI focuses on energy efficiency in the building and industrial sector (cf. Chapter 7.1.2). Pilot projects, the introduction of standards and support mechanisms are paired with strategy development for the upscaling of energy efficiency into policies and regulation.

The UNDP-GEF Energy Efficiency Project looks at improving energy efficiency of household appliances (refrigeration, lamps, electric motors, fans etc.). The project is working closely with the FMENV, the ECN, SON and the NCEEC on the development and introduction of energy performance standards, including MRV schemes and political outreach campaigns.

USAID's Renewable Energy and Energy Efficiency Project (REEEP) aims to facilitate the financing of energy efficiency measures e.g. by offering partial risk guarantees to banks that fund energy efficiency projects.

The French Agency for Development is planning to establish a credit line for energy efficiency measures providing interest-reduced loans.

In the building sector, UN-HABITAT supports (in cooperation with GIZ) FMLHUD in revising the current Nigerian building code by introducing resource efficiency and energy conservation aspects.

On a regional level the ECOWAS Centre for Renewable Energy and Energy Efficiency aims to overcome the technical, financial and capacity related barriers that hinder the implementation of cost effective energy efficiency measures and systems. Main activities are among others the exchange of experience, trainings, and the development of standards. Currently, ECREEE is actively supporting Nigeria in the development of the National Energy Efficiency Action Plan (NEEAP).

7.5 Energy Efficiency Policy and Strategy

To date, there have been a number of barriers impeding the introduction of energy efficiency measures in Nigeria [Oyedepo, S.; Aug 2012]. First and foremost, there has been a dearth in policies promoting and incentivise energy efficiency. However, this is set to change with the approval of the National Renewable Energy and Energy Efficiency Policy developed by the FMP.

7.5.1 National Renewable Energy and Energy Efficiency Policy

The National Renewable Energy and Energy Efficiency Policy (NREEEP) is summarised in Chapter 5.4.11. In relation to energy efficiency, the document identifies as objectives the need to the prudent exploitation of the nation's energy resources, the enhancement of the energy security and self-reliance, the reduction of production cost of energy-dependent goods and services, and finally the protection of the environment. The goals show that the policy is led by the provision of basic services (security of supply) and good conditions to market participants while targets for the wider public receive a subordinate ranking. For the first time, energy efficiency is seen as a source of energy ("NegaWatt") that can be traded and marketed: "Energy efficiency is a source of energy since it would reduce inefficient consumption, thereby providing greater access to electricity consumers."

The document proposes policy measures to achieve these objectives. Among these are:

- The promotion of energy-saving appliances and devices through a nationwide energy campaign and training sessions;

- The implementation of incentives for consumer adoption of energy saving technologies;
- Establishment of incentives for retailers and importers of energy efficient products and promote local manufacturing of such products;
- Changes in public procurement and active replacement of inefficient devices;
- Accounting measures for energy efficiency and saving in electricity tariffs and contracting models;
- Development of energy efficiency building codes (mandating the deployment of energy saving light fixtures in federal government offices and facilities and requiring every new house designed in Nigeria to incorporate energy saving measures);
- Import of more energy-efficient equipment and machinery and fostering of research and development activities in energy conservation and efficiency;
- Promotion of public awareness about the benefits of improved energy efficiency.

The policy sets the following targets:

- Production of guidelines on all the key components of energy efficiency by 2020;
- Enactment of all relevant legislation required for policy implementation by 2020;
- Attain replacement of 40% (by 2020) of old and inefficient appliances in Nigeria with energy efficient appliances;
- Sustain best energy efficiency practices beyond 2030

In order to facilitate the implementation of the targets, the Federal Ministry of Power is currently preparing a National Energy Efficiency Action Plan (NEEAP), which shall provide detailed baseline information on the topic and propose concrete measures to promote energy efficiency. This is part of a regional initiative driven by the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE).

7.5.2 Draft National Energy Efficiency Policy for Nigeria

ECN with support from UNDP/GEF has prepared a "Draft National Energy Efficiency Policy for Nigeria" (status 2013). The document highlights the need to develop a policy comparable with international best practice. It highlights key barriers to energy efficiency and conservation in Nigeria and provides recommendations as to how these barriers can be removed. In order to ensure consistency with the NREEEP (cf. Chapter 5.4.11) developed by the FMP, a name change into "Operational Framework for Energy Efficiency" was discussed, but not concluded. The draft document sets out the objectives aiming at a situation where energy is efficiently utilised, non-energy efficient products are being phased out of the market in favour of energy saving domestic and industrial electrical appliances, energy efficient technologies for buildings, homes and industry are promoted, mandatory labelling of home and office electrical appliances is enforced and energy management is widely institutionalised in the country.

The document sets the following short and long term targets:

- Produce guidelines on all the key components of energy efficiency by 2015;
- enact all relevant legislation required for policy implementation by 2015;
- Nigeria to attain 60% consumption of energy-efficient lighting, refrigerators, freezers and air conditioners by 2016 and 100% by 2020;
- Achieve replacement of 40% (by 2016) and 100% (by 2025) of old non-energy efficient appliances in Nigeria with energy efficient appliances;
- Review and improve on the recommended energy efficiency practices by 2016;
- Sustain best energy efficiency practices beyond 2025.

While the document is well-drafted and its intentions laudable, implementation and due financial resources are imperative before its quality can be assessed meaningfully, as no measures or mechanisms are yet in place destined to enable its targets to be achieved [Oyedepo, S.; Aug 2012]. Similar wording of the targets shows an alignment with NREEEP; however, further efforts have to be made in order to avoid incoherent policy signals.

7.5.3 Standards and Labelling

The concept of Energy Efficiency was not introduced in Nigeria until 2009. So energy efficiency, standards and labelling and Minimum Energy Performance (MEP) are still relatively new in the country. The legislation required to promote and enforce such concepts has not yet been adequately created.

So far, the Standards Organisation of Nigeria (SON) published standards related to energy efficiency, such as a code of practice for the deployment of outdoor solar lighting systems, and standards for self-ballasted lamps, electrical installations of buildings and for safety and performance of CFLs. A list of SON Standards is included in Annex 4, A – 11. Standards for refrigerators, air conditioners, energy management in industry (ISO 50001) and an energy building code are under development, supported by GIZ, UNDP and UN Habitat.

7.6 Energy Efficiency Support Mechanisms

Given the fact that the energy efficiency sector in Nigeria is still in its infancy, the range of support mechanisms is still limited.

7.6.1 Price Incentives

There are currently no price incentives in place. While an elimination of the subsidy on electricity may encourage more energy-efficient behaviour by those who rely on grid-sourced energy, it bears remembering that given the sporadic nature of electricity supplies and the low electrification rate this is not a given as many consumers will rely on diesel generators. That said, subsidies either provided by governmental institutions or NGOs as part of the regime foreseen by the National Policy on Renewable Energy and Energy Efficiency could encourage target groups to invest in energy efficiency activities, to overcome the high up-front costs of introducing such technologies. This would be necessary to expedite the spread of solar water heaters, improved kerosene cooking stoves and subsidies for CFL bulbs.

7.6.2 Tax Relief

The FMENV is trying to obtain a tax relief on importation of energy efficient light bulbs.

7.6.3 Financing Mechanisms / Opportunities

USAID has initiated a credit line with Eko Bank that provides partial risk guarantees to the bank, thereby bringing down the interest rate and collateral requirements for loans. Other lenders from the financial cooperation sector, such as KfW and AFD, are planning interest-reduced credit lines for Nigerian banks.

7.7 Conclusions

Energy Efficiency Potentials

Understandably given the shortfall in generating capacity and, as will be seen in Chapter 8, the lack of access to electricity in many parts of the country, the focus among policymakers has to date been more on energy generation and renewable energy. However, the potential for energy efficiency is to be found at both the generating and the consuming ends of the energy market.

Similar to the public sector, the Nigerian industrial and manufacturing sectors present attractive opportunities for the energy efficiency industry. Promising potentials to generate energy savings via improved load and energy management exist in particular in chemicals & pharmaceuticals, metal products, plastics, textiles and cement.

Planned Energy Efficiency Projects

Several projects with reference to energy efficiency are in the pipeline. They are supported by Ministries (FMP, FMENV, etc.) and international development cooperation organisations (e.g. UNDP, GIZ, USAID). Except GIZ vie its European Union and German Government funded Nigerian Energy Support Programme, no other institution is following energy efficiency projects in the industrial sector.

Policy and Strategy Targets

Barriers that are impeding the introduction of energy efficiency measures in Nigeria are the lack of harmonised and operationalised policies to actively promote and incentivise energy efficiency. There are no codes and regulations that cater to energy efficiency programs. These challenges are further hampered while there is no clear public institution in the lead for coordinating policies and strategies. This is set to change with the adoption of the National Renewable Energy and Energy Efficiency Policy in May 2015 and a consequent strive of the FMP to take the lead in promoting energy efficiency in Nigeria.

Support mechanisms

The key to unlocking the vast potential for energy efficiency in Nigeria today would be a coordinated introduction of support mechanisms. Thus far, the lack of operationalised policies does not provide for existent support mechanisms. The recently approved NREEEP demands price and tax incentives, but those are neither fleshed-out in detail nor put into effect.

8. RURAL ELECTRIFICATION, INCLUDING OFF-GRID RENEWABLE ENERGY

The Draft Rural Electrification Strategy and Plan (RESP, April 2015) prepared by the FMP clearly stipulates targets for rural electrification on the part of the Federal government: *"In the National Electric Power Policy and the more recent Rural Electrification Policy, the FGN has set an ambitious target: to make reliable electricity available to 75% and 90 % of the population (rural or urban) by 2020 and 2030 and at least 10% of renewable energy mix by 2025."*

In order to gauge the plans for roll-out of rural electrification schemes, the magnitude of the challenge must be considered. At present, the FMP estimates that perhaps as many as 70,000,000 Nigerians in rural areas lack access to reliable electricity supply. The FMP puts this in the context of its overall electrification targets and suggests that *"only if by 2020 urban electrification reaches 95% and rural electrification reaches 60%"* will it prove possible to reach the national target of 75% electrification. It goes on to say that *"this will only happen by connecting more than 10,000,000 additional rural households. The new generating capacity required serving the additional domestic and non-domestic rural demand is around 6,000 MW. This is more than the current capacity of the entire Nigerian power system. Achieving this would take the rural electrification rate to 60%."* [FMP; 2015] The electrification rate calculated by the World Bank for 2011 was 48.0% [67]. The enormity of the task of rural electrification at hand is thus adequately described. Plans based on this will entail huge costs that would place strain on the national budget.

8.1 Rural Electrification Market

The process of rural electrification has long been a focus of Nigerian policymakers. However, the sheer scale of the undertaking and the attendant impact on budgets has prevented successive administrations from fielding decisive solutions to meet the target of electrifying 75% of the population (Vision 20:2020). In general this can be achieved by:

- expanding the national electricity grid to rural areas
- using mini- or off-grid systems
- standalone systems like Solar Home Systems (SHS).

This chapter will focus on the latter two options.

With the emergence of renewable energy sources the opportunities to achieve rural electrification using standalone and off-grid systems have improved markedly. For this reason alone, the sector is being revisited by the government, in line with its commitment to *"facilitate the extension of electricity services to all Nigerians, irrespective of where they live and work."* [FMP; 2015]

The electrification rate calculated by the World Bank for 2011 was 48.0% [67]. According to UNESCO and IEA, the electrification rate in Nigeria in 2009 was 50.6%, while triangulation of available data suggests that total grid access to electricity hovers around 35 – 40 % [NIAF, 2014]. The differing data show the difficulty to define and calculate the access rate, but the tendency is in the same range. However, it bares noting that many more households might be technically connected to the grid (state government officials regularly mention figures of 80% of grid coverage), which however don't receive or only get a very limited amount of electricity – hence it has to be kept in mind that access to electricity and grid coverage are two different issues in Nigeria.

However, data reflect the considerable extent of self-provision and backup generation of electricity in Nigeria; in form of large generators in industry and by many big commercial establishments. At the other end of the spectrum there are the ubiquitous small portable generators used by households and shops to supply electricity at very high unit cost. The extent of self-provision is a function of the sector's inefficient performance in delivery of affordable and reliable access.

Table 8 – 1 displays the household electrification rate by geopolitical zone and federal states, whereby according to this data set (National Bureau of Statistics), the electrification rate sits at 55.6%.

TABLE 8–1:
HOUSEHOLD ELECTRIFICATION RATE BY STATE IN %

State of Residence	Have Electricity	No Electricity	Missing	Number of hh surveyed
North Central	**48.7**	**51.2**	**0.1**	**5,942**
FCT-Abuja	77.7	22.0	0.3	361
Benue	22.1	77.9	0.0	1,365
Kogi	62.9	37.1	0.0	876
Kwara	90.6	9.1	0.3	617
Nasarawa	33.2	66.5	0.3	550
Niger	51.7	48.2	0.1	1,504
Plateau	36.3	63.7	0.0	669
North East	**29.3**	**70.4**	**0.3**	**5,115**
Adamawa	37.6	62.2	0.2	726
Bauchi	29.3	70.3	0.4	932
Borno	33.0	66.5	0.5	1,560
Gombe	48.1	51.8	0.1	464
Taraba	10.9	88.8	0.3	634
Yobe	18.1	81.7	0.2	799
North West	**42.2**	**57.7**	**0.1**	**9,992**
Jigawa	26.0	74.0	0.0	1,152
Kaduna	53.5	46.2	0.3	1,915
Kano	52.1	47.9	0.0	2,606
Katsina	31.3	68.5	0.2	1,257
Kebbi	44.4	55.6	0.0	1,069
Sokoto	38.9	60.9	0.2	898
Zamfara	29.1	70.6	0.3	1,096
South East	**66.4**	**33.6**	**0.0**	**4,687**
Abia	81.7	18.3	0.0	644
Anambra	88.1	11.8	0.1	1,050
Ebonyi	39.2	60.7	0.1	978
Enugu	55.4	44.6	0.0	920
Imo	69.9	30.1	0.0	1,096
South South	**68.3**	**31.3**	**0.4**	**5,239**
Akwa Ibom	68.0	31.8	0.2	892
Bayelsa	52.5	47.3	0.2	322
Cross River	57.4	41.4	1.2	848
Delta	78.3	21.6	0.1	946
Edo	82.4	17.5	0.1	702
Rivers	65.1	34.5	0.4	1,529
South West	**81.1**	**18.8**	**0.1**	**7,546**
Ekiti	92.7	7.3	0.0	376
Lagos	99.3	0.5	0.2	2,240
Ogun	72.0	27.9	0.1	1,355
Ondo	66.3	33.7	0.0	920
Osun	89.4	10.6	0.0	853
Oyo	66.6	33.3	0.1	1,802
Total	**55.6**	**44.2**	**0.2**	**38,522**

Source: [NBS; 2014]

8.1.1 Renewable Energy and Rural Electrification Potentials

This chapter refers to renewable energy as means of rural electrification, i.e. small-scale "off-grid" systems opposed to grid-connected renewable energy (cf. chapter 6).

Reporting current off-grid capacity and generation is undoubtedly challenging. Even when generators of 1 MW or more must be registered with the Federal Ministry of Power (FMP) only limited actual data is available. There is an estimated installed capacity of 8 – 14 GW off-grid diesel and gasoline generators the majority of which is installed by individual people in urban areas to cover power outages from the national grid. Households in rural areas usually cannot afford to buy and operate gensets.

For renewable energy sources, there is no difference in principle between the potential for rural projects than those for grid-connected utility-scale projects, other than the fact that economies of scale may make the rural projects more expensive. However, off-grid renewable energies are economically more interesting in case of remote areas with poor accessibility and hence high alternative fuel costs.

Chapter 6.1.1 refers to the general potential of renewable energies in Nigeria (including solar and wind).

Below, an attempt is made to assess the potential for the site-specific small hydro and biomass plants. The general solar energy potential is shown in Chapter 6.1.1.3; since solar plants can basically be set-up anywhere, no rural electrification specific analysis is provided.

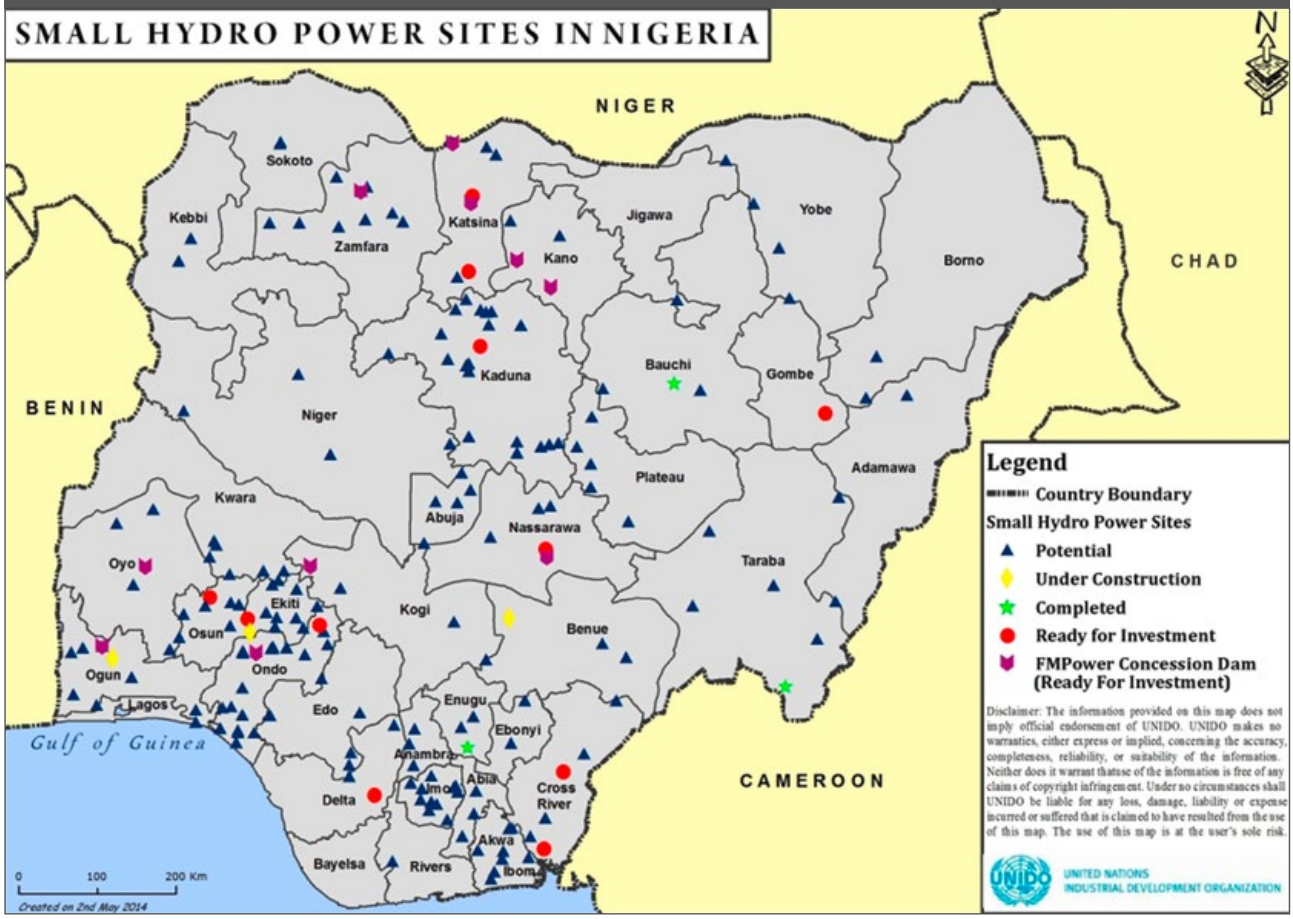
Mini, Micro and Small-Hydro

In 1980, UNIDO listed a set of project opportunities for small hydro power development in Nigeria. This list is certainly outdated, however it gives an overview of what potential is available for rural electrification by small hydro power projects. The list is included in Annex 4, Table A – 15.

The ECOWAS Small Scale Hydropower Programme [72] estimates the small scale hydropower potential at about 414 MW in 97 sites, whereby only sites with a potential below 30 MW are counted. The ECN in its Renewable Energy Master Plan sees the potential even at 3 500 MW. [Vincent-Akpu, I.; 2012] a total of 70 micro dams, 126 mini dam and 86 small sites have been identified.

However, the actual potential has to be carefully studied for each individual site, since a huge seasonal difference in the water flow may render sites that look promising in the rainy season economically and technically inviable in the dry season (cf. Chapter 6.1.1.2).

FIGURE 8 – 1:
SMALL HYDRO POWER SITES IN NIGERIA



Source: UNIDO

Biomass/Biogas

As shown in Chapter 6.1.1, Nigeria has a wide range of biomass resources usable decentralised and off-grid. Apart from municipal solid waste for large scale grid-connected energy production, it has been estimated that Nigeria produces about 227,500 tons of fresh animal waste daily. Since 1 kg of fresh animal waste generates about 0.03 m3 biogas, then Nigeria can potentially produce about 6.8 million m3 of biogas every day from animal waste only. Assuming an electricity production of 5 to 7,5 kWh/m3 biogas, this amount of biogas is sufficient to generate yearly 12,400 – 17,400 GWh. Nevertheless, the total potential of biomass for off-grid generation has still to be quantified.

8.1.2 Existing Rural Electrification Projects

According to the Rural Electrification Agency (REA), more than 1000 projects have been completed. Limited details are available on capacity, energy produced, or consumers supplied. Likewise, no details are available on technology; however, the bulk of it can be assumed to be grid extension. [REA; 2013]

TABLE 8 – 2:
REA, SUMMARY OF PROJECTS/PROGRAMMES

Total no. of projects	Total no. of projects completed	On-going
2499	1,008	1,491

Geographically speaking, the projects are said to be distributed evenly across the country's geopolitical zones. The Association of Rural Electrification Contractors of Nigeria (ARECON) has said that 50 of the 280 contracts awarded to its members by the Rural Electrification Agency (REA) in 2013 are presently ready for commissioning, but project details are not available. The REA faces the difficulty that all its projects are too small for the main backbone of 33 kV lines. Hybrid systems that switch between diesel and solar PV power generation have yet to be deployed but would definitely make sense in many areas as they would ensure cost-efficient delivery of power around the clock, and thus could be used to power critical infrastructure and agricultural equipment, such as water pumps.

Solar Projects

In 2011, NERC listed 58 solar-based rural electrification projects across the country.

From a survey including 53 companies carried out by the Nigerian Energy Support Programme (NESP) in 2015, in total these companies had installed 115 MW of off-grid photovoltaic combining mini-grids and stand-alone systems. Most of them have been installed for residential or commercial purposes in un-electrified rural areas. Some have also been built in grid-connected areas as backup systems. Most of the projects were financed with grants from international donors or the federal, state and local government.

In 2014, the FMP launched a new national programme called "Operation Light-Up Rural Nigeria" [49], [50]. The project intends to install three solar-powered mini-grids in each of the 36 federal states. In early 2014, the first pilot solar-driven system under the scheme was installed by a French company in Durumi, Bwari Area Council of Abuja, using a 3.5 kVA standalone system; three further systems have since been installed in the surroundings of Abuja.

The Rural Energy Access Project (REAP) was launched by the FMENV's Renewable Energy Programme to create alternative and sustainable clean and renewable energy sources for lighting purposes. REAP is proposing a reduction in power consumption (by using clean, energy efficient LED bulbs) and introducing household standalone solar kits to replace incandescent bulbs, single-wick kerosene and oil lamps and small diesel generators. The goal of the project is to ensure affordable and sustainable clean energy access to the rural poor and reduce black carbon.

The Sokoto Energy Research Centre (SERC), together with the World Bank, the Energy Commission of Nigeria and the Sokoto Government, installed a hybrid mini-grid combining 10 kW solar and 2 kW wind power in Danjawa Village, Sokoto. Other technologies such as off-grid photovoltaic street lighting have also been tested in Danjawa and other parts of the country. Another PV/wind hybrid plant with 10 kW of solar PV and three wind turbines with a combined capacity of 15 kW has recently been inaugurated at the NAPTIN Regional Training Centre in Kainji. This project was funded by the German Federal Foreign Office and implemented by GIZ.

The NGO Solar Sisters combines the potential of solar and clean cooking technology with a deliberately woman-centred direct sales network to bring light and opportunity to remote communities in rural Nigeria and other countries in Africa. Solar Sisters provide the women with a "business in a bag", a start-up kit of inventory, training and marketing support. In 2014 about 1000 entrepreneurs achieved that about 180,000 people are benefitting from solar light in 3 countries (Nigeria, Ruanda and Tanzania) [54].

Biomass Projects

- Global Biofuels Ltd is developing a biofuel production Complex at Ilemeso in the northern part of Ekiti state of Nigeria. Similar plants are planned in other states.
- Renewable Energy Programme office, Adamawa State Government and Green Carbon Afrique is developing sugarcane based biofuel plants covering 2,000 hectares plantation. This integrated project should be replicated in ten states of the country.
- Carbon Quest and Adamawa State is establishing an integrated rice processing and power generating facilitator as a source of self-generated power from rice-husk and of power for urban and rural communities.

8.1.3 Planned Rural Electrification Projects

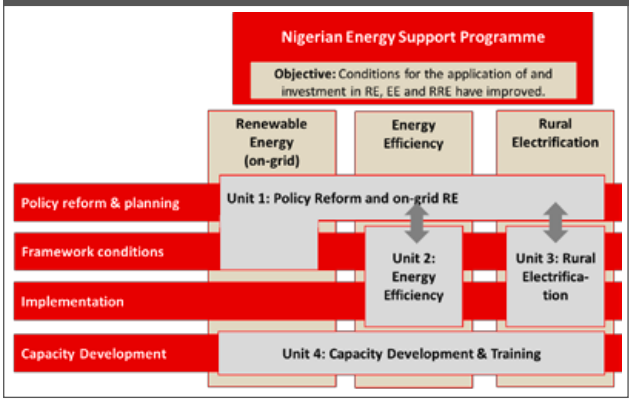
In July 2014, the Rural Electrification Agency (REA) tendered the 2nd batch of rural electrification projects under 2014 FGN capital appropriation comprising 175 projects in three categories:

- extension or the completion of extensions of electricity lines including e.g. 300 or 500 kVA transformers at 33 kV / 0.415 kV level, 11 kV control rooms
- rural electrification projects at various locations
- provision and installation of solar street light at various locations

Several kilometres of solar street lighting were deployed by the state and local government councils.

The activities under the Nigerian Energy Support Programme are structured as indicated in Figure 8 – 2. Under its component 3 "Rural Electrification and Sustainable Energy Access", the electrification of 10 villages, municipal institutions and/or commercial production sites using renewable energy is under development. The pilot projects shall demonstrate the viability of renewable energy technologies for rural electrification and provide sustainable private-sector driven business models for their large scale replication across the country. Community-based approaches, productive use application and women empowerment will be included as main aspects of the pilot projects. NESP is implemented by GIZ and funded by the European Union and the German Government.

FIGURE 8 – 2:
NIGERIAN ENERGY SUPPORT PROGRAMME (NESP)



8.2 Rural Electrification Stakeholders

Due to the limited coverage of grid infrastructure in rural and semi-urban areas of the country, REA has a remarkable role to support standalone and off-grid renewable energy systems while NERC covers the grid extension regulation. Close coordination between REA and NERC is therefore equally important, as detailed in Chapter 4.

8.2.1 Public Authorities and Their Roles

A detailed overview of the "institutional and policy mapping of the renewable energy, energy efficiency and rural

electrification subsectors in Nigeria" is given in the eponymous publication [GIZ; Oct 2013].

In general, energy is a concurrent competency between the federal government and the states of Nigeria. The federal government regulates power generation and transmission on national grid level, while the federal states have a mandate for off-grid areas. States may install new generating capacities within their boundaries and operate Independent Electricity Distribution Networks (IEDNs, i.e. networks not connected to the distribution grid. In practice, states also engage in grid extension, although this is under the privatized market order the prerogative of the DISCOs Even state managed power generating companies have been funded. Many states have a State Rural Electrification Board or a State Electrification Agency, and these are developing i.e. energy strategies at the state level. According to the EPSR Act 2005, they are coordinated by the Rural Electrification Agency (REA), which however in reality is only rarely the case.

The **Rural Electrification Agency (REA)** is a public authority, based in Abuja, charged with the responsibility coordinating rural electrification activities (see also Chapter 4.1.1.2). The agency shall manage the Rural Electrification Fund (not operational yet) and has a key role to play in ensuring that standalone and off-grid renewable energy systems are equally promoted a. The legal framework for the REA is outlined in the EPSR Act 2005. The REA was established as an agency affiliated to the FMP and has offices in the six geopolitical zones.

The **Federal Ministry of Power (FMP)** is responsible for policy development on increasing access to electricity and will thus set and revise targets as required. FMP currently leads the ICREEE and is actively involved in ensuring that power/electricity is available to the citizens from all forms of energy. (cf. Chapter 4.1.1)

The **Federal Ministry of Environment (FMENV)** has launched a Renewable Energy Access Project (REAP, see Chapters 4.1.2 and 8.1.3).

The **Federal Ministry of Science and Technology (FMST)** is involved in numerous renewable energy, energy efficiency and rural electrification activities. The renewable energy, bio-fuel and biomass section of one of its departments coordinates research activities in renewable energy (wind, solar, biomass etc.) especially in terms of electricity generation and supply to rural areas where grid connection is unavailable. Through the National Agency for Science and Engineering Infrastructure (NASENI), FMST has completed a 7.5 MW solar panel manufacturing plant in Abuja and a 10 kW hydro power plant at Ketti Site in Abuja. [Haruna, M.S.] (cf. Chapter 4.1.3)

The **Nigerian Electricity Regulatory Commission (NERC)**'s role is the establishment of rules and regulations for extending the grid to rural customers. This involves setting of the tariffs and ensuring that all utilities and distribution companies comply strictly with the law regarding feeding electricity generated from renewable energy into the grid. Regulatory policy with regards to relevant renewable energy schemes shall also be developed by NERC in consultation with stakeholders. While according to the EPSR Act NERC's main mandate rests on regulating generation capacities above 1 MW and or distribution capacities above 100 kW, the draft Rural Electrification Strategy and Plan (RESP) enables NERC to develop a regulatory framework for installations below this framework. Against this background, NERC has started working on a light-handed regulation for mini-grid based rural electrification with generation capacities less than 1 MW. (cf. Chapter 4.1.1.3)

The **Energy Commission of Nigeria (ECN)** has the overall lead in promoting all forms of energy by gathering and disseminating information of same as well as leading research and development of the sector in the country.

ECN has supported some pilot projects, such as a PV-wind hybrid plant in a village close to the Sokoto Energy Research Centre (the centre). (cf. Chapter 4.1.3.1)

8.2.2 Rural Electrification Market Players

Distribution Companies have the mandate – and obligation – to extend the grid to previously un-electrified regions. However, given the huge investment requirements to upgrade the existing network infrastructure, DISCOs will focus on consolidating the existing customer base and extend the grid to the most profitable areas. Since DISCOs are not mandated to establish and operate generation capacities, their role in off-grid electrification is limited to operating independent distribution networks, which under the present conditions is not a priority.

In the absence of a meaningful market, there is only a limited number of private actors in the renewable energy-based rural electrification sector. In order to lay the basis for entering a future market, various component and system suppliers have implemented demonstration projects (solar panels, battery packs, etc. that provide lighting), but no long-term sustainable solution has yet been devised. International companies are the major drivers behind the "Operation Light Up Rural Nigeria" project (cf. Chapter 8.1.2) and have provided, at no cost, installations for pilot projects in order to stimulate a market in rural electrification. [13]

However, once policy and an investor-friendly regulatory framework is in place, and once it becomes clear which application track is required for accessing subsidies for capital costs, project developers may find that there is latitude for engagement.

After privatisation of the distribution companies, they are obliged to provide the inhabitants of the region with sufficient electricity. However, private companies tend to operate at low cost and high margins to be profitable. People in remote areas are usually not able to pay high electricity bills. That is why a real market for rural electrification does not exist. State governments note this problem and support rural electrification programs.

8.3 Rural Electrification Policy and Strategy

8.3.1 Draft Rural Electrification Strategy and Plan (RESP)

The draft Rural Electrification Strategy and Plan (RESP) is a key document as it brings the strands of policy making into a coherent form. However, in its version of April 2015 it still remains a draft and has not yet been enacted by government. It states quite unequivocally that rural electrification is a federal matter: *"1. The FGN shall facilitate the provision of steady and reliable electric power supply at all times, at economic rates, for residential, commercial, industrial, and social activities in the country."* In terms of actual coordination of activities, it falls to the REA, the sole bearer of a mandate, to implement the legislation and act as the intermediary between central government, the states and local government areas; while NERC is given the responsibility to develop a light-handed regulation for the sector. The REA delegates financing issues to the Rural Electrification Fund (REF).

The policy document places an important emphasis on the role of various forms of renewable energy technologies in helping to meet the electricity needs of the rural areas of the country at a cost-effective and affordable price. Thus, as one of the guiding principles of the Nigerian rural electrification strategy, the RESP states that the FGN shall facilitate the promotion of private sector participation in rural electrification (on- and off-grid) in the development of the nation's abundant renewable energy resources by creating an enabling environment, while ensuring that governmental agencies, cooperatives and communities, have adequate room to participate in enhanced electricity service delivery. Various rural electricity projects will be carried out through three main processes:

grid extension, mini-grid systems and standalone systems. Renewable energy sources have the capacity to support all of these systems and help to provide reliable and affordable electricity supply which enables rural households to devote less of their time and income to procuring energy supplies, freeing them up for productive use. It could also help ensure that energy is used efficiently and sustainably. [FMP; 2015]

The RESP itself, while acknowledging the need for coordination, seeks to place the implementation of rural electrification squarely on the shoulders of the private sector. RESP declares unequivocally that *"in recognition of the advantages of a bottom-up approach, the FGN will promote a centrally coordinated but demand-driven approach, that is, market-oriented approach to rural electrification. While the REA will still provide overall coordination of rural electrification activities centrally, the development of projects themselves will come from the communities, operators and promoters that identify a particular need. Public-private partnerships will be encouraged, whereby the private sector and community-based organisations will be increasingly responsible for much of the service delivery with the minimum necessary financial support from the public sector."* [FMP; 2015].

The overarching target of the strategy is to achieve 75% electrification by 2020, 90% by 2030 and 100% by 2040. The RESP further outlines what the cost of such a policy is, saying that "achieving the 2020 target of 75% electrification will require between NGN 317.8 and NGN 525.8 billion (US$ 1.9 – 3.3 billion) for administration and project costs combined." [FMP; 20154] Further, the RESP states that a rural electrification implementation plan shall be financed via an independent Rural Electrification Fund operated by the Rural Electrification Agency.

8.3.2 Tariffs

Tariffs are set out in the RESP as follows: "In accordance with the RE Policy and international best practice, tariffs for rural electricity service will be cost-reflective. They shall account for the average annual cost of fuel, operation, maintenance, safety, generation, distribution, revenue collection, spares, equipment and operator fees, expected sales of electricity, generator capacity, number of connections, volume of consumption, and level of service (...) Tariffs will be calculated using appropriate formulae/methodology to be developed by NERC in consultation with project developers and customers." [FMP; 2015]

In relation to projects that fall within the NERC licensing requirements, tariffs will be regulated. In order to ensure light-handed regulation for rural electrification the approach taken will be more gentle. The document also indicates that tariffs should also be prepared taking into consideration the specific context of rural areas in which operators have to face higher risks and uncertainties. A second approach for tariff setting mechanism for new projects is also mentioned allowing project developers to set the tariffs outside of the tariff model provided that prospective consumers for at least 60% of the proposed output have signed acknowledgements that they are willing to pay this tariff. The RESP also mentions that controls, reviews and oversight will be less stringent and burdensome on operators. Tariffs will be reviewed annually and recorded in the Electricity Supply Contract between consumers and RE service providers after obtaining NERC approval. In case of capacity stipulated in the EPSR Act 2005, NERC will retain responsibility for monitoring and enforcing agreed-upon tariffs.

This is without doubt a laudable and viable structure, assuming rural communities have the financial means to pay the cost of electricity generation and distribution; whereby it bears stating that this is presumably an ideal-typical scenario. However, it in effect introduces an asymmetric relationship between urban and rural areas. Given that urban environments at present benefit from electricity subsidies, they currently do not pay a cost-reflective price.

8.3.3 Further Policy Documents

A whole host of acts and by-laws cover rural electrification as further detailed in Chapter 5. They include the following:

- National Electric Power Policy (NEPP, 2001)
- National Energy Policy (2003)
- Electricity Power Sector Reform Act (EPSRA, 2005)
- Rural Electrification Policy (2006)
- Rural Electrification Strategy and Implementation Plan of the Federal Republic of Nigeria (RESIP, 2006)
- Rural Electrification Policy Paper (REPP, 2009)
- Regulations for Independent Electricity Distribution Networks (IEDN, 2012)
- Draft Rural Electrification Strategy and Plan of the Federal Republic of Nigeria (RESP) (FMP, April 2015)
- Draft NERC Mini-Grid Regulations (NERC, June 2015)

NERC is currently preparing with the assistance of GIZ a regulatory framework for mini grids. The regulations will distinguish between mini-grids of up to 100 kW ("regulatory guidelines") and mini-grids larger than 100 kW and smaller than 1 MW ("light-handed regulation"). The regulations shall ensure investment security by inter alia establishing a tariff setting mechanism and determining a protocol for handover of assets and compensation mechanisms in case the mini-grid gets inter-connected to the main grid. At the same time, the regulation will ensure the protection of consumers and the environment.

The Regulations for Independent Electricity Distribution Networks (IEDN) creates the framework for distribution networks not connected to the distribution or transmission system.

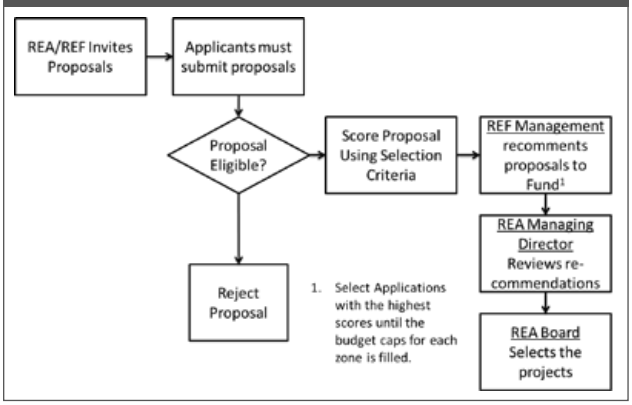
8.4 Rural Electrification Support Mechanisms and Price Incentives

The (not yet operational) Rural Electrification Fund (REF) so far is the only government-led structured funding mechanism. The incentives are designated to be infrastructure based (incentives to reduce the installation costs) and not electricity-production based (incentives to reduce the consumption costs). The REF will function as a "challenge fund", i.e. interested parties are expected to submit applications in consecutive rounds of competition, whereby projects will be selected according to a transparent set of criteria (see Figure 8 – 3):

- Economic and financial viability, with the initial capital subsidy;
- Promotion of social and economic objectives;
- The choice of technology to be used (e.g., preferential scoring of RE projects);
- Cost-effectiveness;
- Nature and extent of community support; and
- Investor commitment.

The REF will only "supply some proportion of the total funding so that other parties (distribution companies, local communities, business groups, etc.) would have to provide the rest." [FMP; 2015].

FIGURE 8 – 3:
REF SELECTION PROCESS



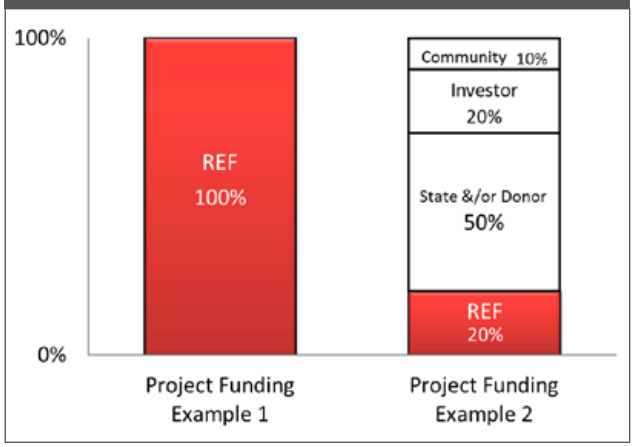
Source: [FMP; 2015]

Source of Funds

The fund will consist in accordance to the EPSR Act 2005 of fines obtained by NERC, donations, gifts or loans made by international agencies, state governments, the federal government, local communities, businesses or any other entity. Finally, rural electrification developers, including the DISCOs, shall be engaged in a public private partnership by the REA. [FMP; 2015]

Co-funding of individual projects with other sources of funds multiplies the benefits delivered by the REF. Co-funded projects are expected to be the most successful in competing for REF funding. The REF has initially been equipped with a seed funding of 2 billion Naira by the Federal Government; however, pending the approval of the RESP, it has not been operationalized so far. Figure 8 – 4 shows possible REF funding scenarios, whereby the second example is clearly the preferred funding arrangement.

FIGURE 8 – 4:
EXAMPLES FOR REF PROJECT FUNDING



8.5 Conclusions

Rural Electrification Market and Potentials

The market potential for rural electrification is huge, since the current electrification rate in Nigeria is just around 50 %. It could be worth pursuing small solar PV installations, mini or small hydropower plants and larger hybrid systems to provide electricity to rural communities. Even small decentralised biogas projects offer vast potential.

Off-grid generation is undoubtedly challenging. However, the REA has about 600 projects ongoing, mainly in the field of solar energy and energy efficiency. Other small projects are being pursued by various institutions and companies.

Strategy, Stakeholders and Support Mechanism

The draft Rural Electrification Strategy and Plan (RESP) sets a target of 75% electrification by 2020 which shall be achieved in a private-sector driven approach. Since the operationalization of the Rural Electrification Fund – the only public funding vehicle – depends on the enactment of the RESP, urgent action is needed.

FMP, REA, NERC, state governments and DISCOs are the main players in Nigeria's rural electrification sector. Efforts to embark on a coordinated approach are visible, however still need to be improved. The preparation of electrification plans at national, regional and/or state-level would be an important tool to coordinate the different stakeholder interests and embark on a structured large-scale roll-out of electrification projects. The World Bank and GIZ have initiated support activities in this regard.

9. CONCLUDING REMARKS

While Nigeria has overtaken South Africa as the biggest economy on the continent, the electricity sector as the backbone of the economy significantly lacks behind. Power outages are a daily routine, and so are the cues in front of the petrol stations.

However, Nigeria has made remarkable efforts in the last two years to address this situation:

The privatization of the power sector in November 2013 is the basis for a transition into a rule-based, efficient and reliable electricity market.

Under the umbrella of the Electric Power Sector Reform Act, new institutions have been established and policies have been designed which shall mainstream these new principles into the different sub-sectors.

The approval of the National Renewable Energy and Energy Efficiency Policy is a clear sign that the potential of clean energy technologies for the promotion of a reliable and sustainable electricity sector has been recognized. Further, it is an important step towards harmonizing the previously scattered policy landscape in the clean energy sector.

Going forward it is imperative that an equally concerted effort is being made to turn the policy goals into practice.

For on-grid renewable energy this means that a structured support mechanism has to be devised which on the one hand creates an attractive investment climate for independent power producers, and on the other hand ensures a prudent use of government funds. In line with the current market order, a competitive procurement system for utility-scale and a feed-in tariff for small-scale renewable energy seem to be the best approach.

The rural electrification sector still awaits the approval of the Rural Electrification Strategy and Plan. Operationalization of the Rural Electrification Fund is as important as a coherent planning and regulatory framework in order to promote investments and streamline the actions of federal, state and private actors towards a mass roll-out of electrification projects across the country.

Energy efficiency still needs to be embraced by stakeholders and the population at large as a cost-effective tool to save electricity and to improve the reliability of the power system. Awareness creation measures are as important as mandatory standards and voluntary pilot projects in order to demonstrate the viability of this approach.

Conducting this study has also shown that the availability of data is a major challenge. However, it is hoped that this publication alleviates this situation to a certain extent.

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[15]	Federal Ministry of Power	http://www.power.gov.ng/index.php/department/energy-resources-development **Department " Energy Resources Development"**
[16]	Federal Ministry of Water Resources	www.waterresources.gov.ng/departments/dams-and-reservoir-operations **Department " Dams and Reservoir Operations"**
[17]	Guardian News	www.theguardianmobile.com/readNewsItem1.php?nid=25196 **Article: "All set for Delta gas city project's kick-off"**
[18]	International Centre for Energy, Environment & Development	www.iceednigeria.org
[19]	International Organisation for Standardization	http://www.iso.org/iso/about/iso_members/iso_member_body.htm?member_id=1982 **Member list**
[20]	JBS WindPower Ltd.	jbswindpower.com/our-projects.html
[21]	Leaders & Company Limited	www.thisdaylive.com/articles/fg-targets-75-electrification-across-nigeria/128452/ **Article: "FG Targets 75 % Electrification across Nigeria", 23 Oct 2012**
[22]	Manufacturers Association of Nigeria	www.manufacturersnigeria.org
[23]	National Bureau of Statistics	www.nigerianstat.gov.ng/pages/download/6 **Electricity Supply and Demand Statistics**
[24]	National Planning Commission	www.nationalplanning.gov.ng/index.php/national-plans/nv20-2020 **National Plans**
[25]	National Population Commission	www.population.gov.ng/images/ndhs_data ndhs_2013/2013_ndhs_key_findings.pdf **Nigeria, 2013 Demographic and Health Survey, Key Findings**
[26]	Niger Delta Power Holding Company Limited	www.nipptransactions.com
[27]	Niger Delta Power Holding Company Limited	www.nipptransactions.com/background/purpose/
[28]	Niger Delta Power Holding Company Limited	www.nipptransactions.com/wp-content/uploads/downloads/2013/07/1.-CPCS-NIPP-Roadshow-Presentation.pdf **Privatisation of Niger Delta Power Holding Company Limited Generation Companies, 2013**

REF.	Owner	Link / Document Title
[29]	Niger Delta Power Holding Company Limited	www.nipptransactions.com/wp-content/uploads/downloads/2013/09/Transmission-Development-TCN.pdf **Transmission Plans (2013–2017), 2013**
[30]	Nigeria Electricity Privatisation (PHCN)	www.nigeriaelectricityprivatisation.com
[31]	Nigeria Electricity Privatisation (PHCN)	www.nigeriaelectricityprivatisation.com/wp-content/plugins/download-monitor/download.php?id=69 **The System Operator**
[32]	Nigeria Energy Consortium	www.nigeriaalternativeenergy.org
[33]	Nigeria High Commission London, UK	www.nigeriahc.org.uk/about-nigeria **Nigeria, key data**
[34]	Nigerian Electricity Regulatory Commission	www.nercng.org/index.php/document-library/func-startdown/27/ **The Grid Code for the Nigerian Electricity Transmission System, Version 01**
[35]	Nigerian Electricity Regulatory Commission	www.nercng.org/index.php/industry-operators/codes-standards-and-manuals **Codes, Standards and Manuals**
[36]	Nigerian Electricity Regulatory Commission	www.nercng.org/index.php/industry-operators/licensing-procedures/licencees?limitstart=0 **Licensees**
[37]	Nigerian Electricity Regulatory Commission	www.nercng.org/index.php/nerc-documents/Regulations/orderby,3/ **Regulations**
[38]	Nigerian Electricity Regulatory Commission	www.nercng.org/industry-operators/licensing-procedures/licencees
[39]	Nigerian Electricity Regulatory Commission	www.nercng.org/nercdocs/Regulation-for-the-Application-for-Licence.pdf **Regulation No: NERC - R - 01 10 A**
[40]	Nigerian Electricity Regulatory Commission	http://www.nercng.org/index.php/document-library/func-startdown/26/ **The Distribution Code for the Nigeria Electricity Distribution System, Version 01,**
[41]	Nigerian Institute of Building	www.niobng.org
[42]	Nigerian Investment Promotion Commission	www.nipc.gov.ng/investment.html **Investment Incentives**
[43]	Nigerian Society of Engineers	www.nse.org.ng
[44]	Nigerianisch-Deutsche Energie-partnerschaft	www.ngenergypartnership.de/
[45]	NOI-Polls	www.noi-polls.com
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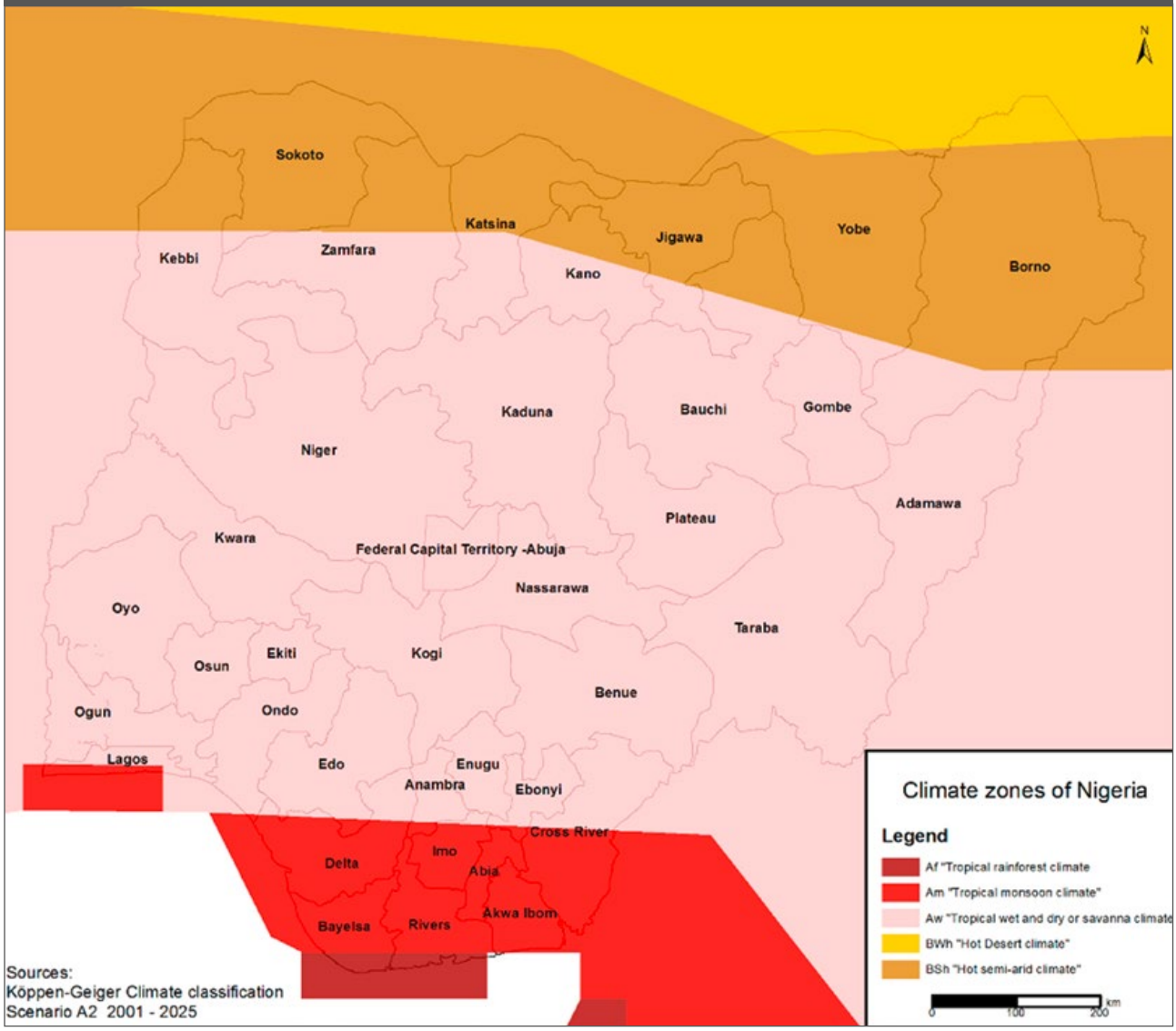
[47]	Organisation of the Petroleum Exporting Countries	www.opec.org
[48]	Presidential Task Force on Power	www.nigeriapowerreform.org/index.php?option=com_content&view=article&id=1195%3Ainvesting-in-nigeria-s-renewable-energy-sector&catid=36&Itemid=336 **Article: "Investing in Nigeria\'s Renewable Energy Sector"**
[49]	Project Light-Up Nigeria	www.projectlightupnigeria.com/rural-electrification-projects.html **Rural Electrification Projects**
[50]	Project Light-Up Nigeria	www.projectlightupnigeria.com/the-project.html **About us**
[51]	Renewable Energy Programme Office; Federal Ministry of Environ-ment	renewableenergy.gov.ng/cross-river-farm-to-produce-biodiesel/ **Cross River farm to produce biodiesel**
[52]	Renewable Energy Programme Office; Federal Ministry of Environ-ment	renewableenergy.gov.ng/projects/ **Projects**
[53]	Securities & Exchange Commission, Nigeria	www.sec.gov.ng/files/Prof%20Nnaji%20Presentation.pdf **Power Sector Outlook in Nigeria: Governments Renewed Priorities, 2011**
[54]	Solarsister	www.solarsister.org
[55]	Standards Organisation of Nigeria	www.son.gov.ng
[56]	Statehouse office of the President, Federal Republic of Nigeria	www.statehouse.gov.ng/
[57]	Subsidy Reinvestment and Empow-erment Programme Committee	www.sure-p.gov.ng

REF.	Owner	Link / Document Title
[58]	The Association of Nigerian Solar Energy Promoters	www.ansep.org
[59]	The Federal Ministry Of Information	www.nigeria.gov.ng/2012-10-29-11-05-46 **About Nigeria**
[60]	The Nigerian Institute of Architects (NIA)	www.nigerianinstituteofarchitects.org
[61]	UNICEF	www.unicef.org/infobycountry/nigeria_statistics.html#99 **At a glance: Nigeria**
[62]	United Nations	unstats.un.org/unsd/energy/edbase.htm **Energy Statistics Database**
[63]	US DOE, U.S. Energy Information Administration	www.eia.gov/countries/ **Countries**
[64]	US DOE, U.S. Energy Information Administration	www.eia.gov/countries/cab.cfm?fips=NI **Nigeria**
[65]	Vanguard Media Limited, Nigeria	www.vanguardngr.com/2013/01/nigeria-spends-n3-5trn-annually-on-power-generators/#sthash.1V0cklN3.dpuf **Article: "Nigeria spends N3.5trn annually on power generators", January 16, 2013**
[66]	World Bank Group	data.worldbank.org/country/nigeria **Data Nigeria**
[67]	World Bank Group	data.worldbank.org/indicator/EG.ELC.ACCS.ZS **Data Access to electricity (% of population)**
[68]	World Bank Group	data.worldbank.org/indicator/EG.USE.COMM.GD.PP.KD **Energy use (kg of oil equivalent) per $1,000 GDP (constant 2011 PPP)**
[69]	World Bank Group	www.doingbusiness.org/data/exploreeconomies/nigeria **Nigeria**
[70]	World Energy Council	http://89.206.150.89/documents/congresspapers/57.pdf **Energy Efficiency and Barriers towards Meeting Energy Demand in Industries in Nigeria**
[71]	World Green Building Council	www.worldgbc.org/worldgbc/members/ **Member List**
[72]	ECOWAS Center for Renewable Energy and Energy Efficient (ECREEE)	http://www.ecreee.org/page/ecowas-small-scale-hydro-power-program-sshp **ECOWAS Small Scale Hydro Power Programme (SSHP)**
[73]	Nigerian Electricity Regulatory Commission	www.nercng.org/index.php/document-library/func-download/312/chk,d6b1bfbe-4d840a2d18d6206c31798caa/no_html,1/ **Market rules - For Transitional and Medium Term Stages of the Nigerian Electricity Supply Industry**
[74]	Nigerian Electricity Regulatory Commission	www.nercng.org/index.php/document-library/func-download/357/chk,2c9858907b79e483b74cb5ae57aaf3a0/no_html,1/ **Rules for the interim period between completion of privatisation and the start of the transitional electricity market (TEM) 2013**
[75]	Detail Commercial Solutions	http://www.detailsolicitors.com/?section=news&cmd=details&newsid=49 **The declaration of the Transitional Electricity Market (TEM) and stakeholder expectations for the Nigerian Electricity Supply Industry (NESI)**
[76]	This Day	http://allafrica.com/stories/201503022303.html **Nigeria: Revenue shrinks by 28 % amid oil price slump**
[77]	International Energy Agency	http://www.iea.org/statistics/statisticssearch/report/?country=NIGERIA&product=electricityandheat&year=2012
[78]	This Day	http://www.thisdaylive.com/articles/relief-as-fuel-subsidy-claims-drop-to-90-kobo-per-litre/198484/ **Relief as Fuel Subsidy Claims Drop to 90 kobo per Litre**
[79]	UNDP	http://www.ng.undp.org/content/nigeria/en/home/operations/projects/environment_and_energy/promoting-energy-efficiency-in-residential-and-public-sector-in-.html **Promoting Energy Efficiency in Residential and Public Sector in Nigeria**
[80]	African Development Bank	http://nigeria.opendataforafrica.org/

12. ANNEXES

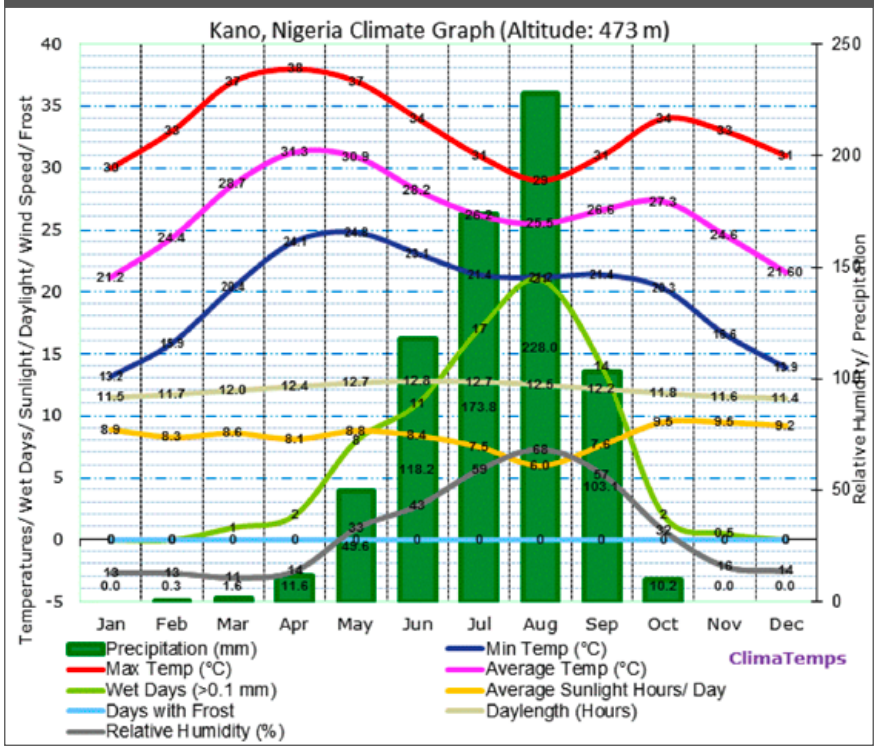
12.1 Supplementary Climate and Socio-Economic Data

FIGURE A – 1:
CLIMATE ZONES OF NIGERIA



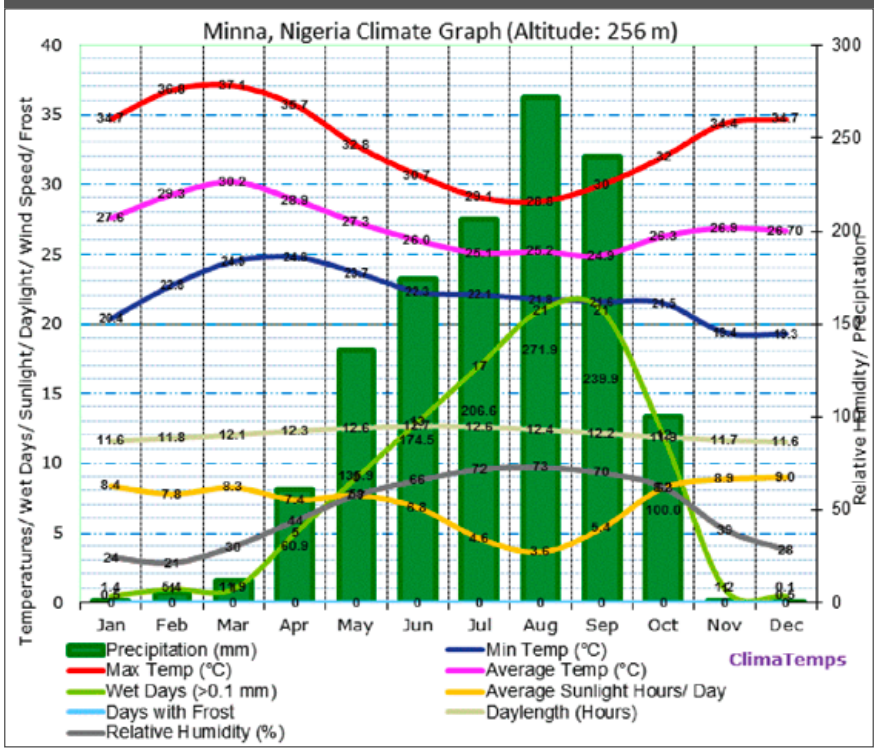
(Prepared by GOPA-International Energy Consultants GmbH)

FIGURE A – 2:
CLIMATE CHARTS FOR KANO (BSH)



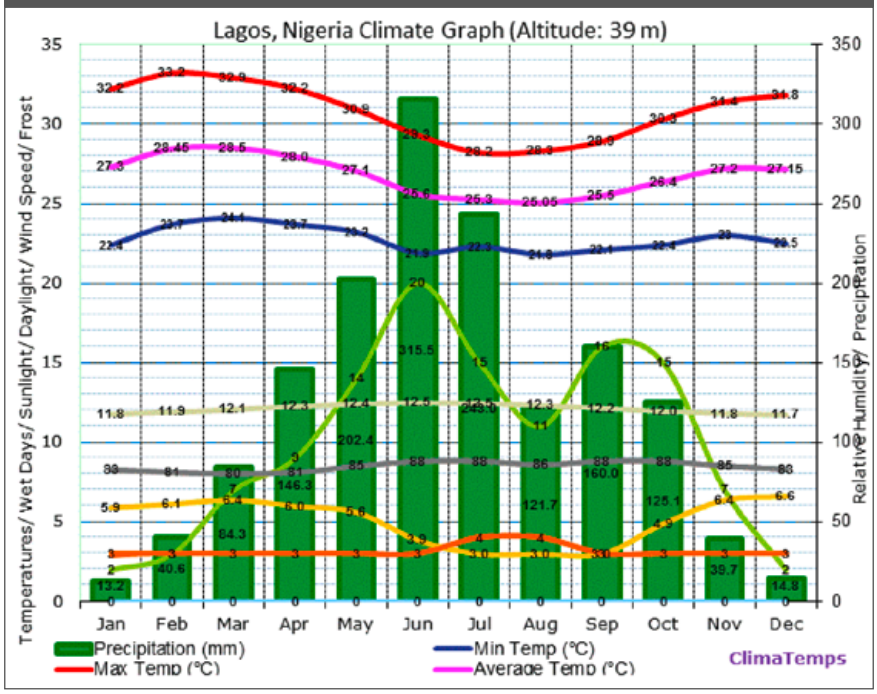
Source: Climatemps, [4]

FIGURE A – 3:
CLIMATE CHARTS FOR MINNA (AW)



Source: Climatemps, [4]

FIGURE A–4:
CLIMATE CHARTS FOR LAGOS (AM)



Source: Climatemps, [4]

TABLE A – 1:
ANNUAL RAINFALL IN NIGERIA BY STATE, 2005 – 2009 (MILLIMETRE)

States and Capitals	2005	2006	2007	2008	2009
Abia (Umuahia)	125.3	171.7	135.5	144.2	1,980.1
Adamawa (Yola)	865.7	1,057.3	827.4	468.5	718.1
Akwa Ibom (Uyo)	2,711.8	2,558.7	2,532.2	2,106.2	1,911.7
Anambra (Awka)	159.7	1,910.3	2,026.8	2,056.7	2,273.4
Bauchi (Bauchi)	1,104.5	1,017.9	1,136.9	1,133.1	1,621.3
Bayelsa (Yenagoa)	–	–	–	–	–
Benue (Makurdi)	871.3	1,343.0	1,339.9	1,050.7	1,401.5
Borno (Maiduguri)	917.3	553.7	1,076.3	600.9	587.5
Cross River (Calabar)	3,862.1	2,896.8	3,427.9	3,060.8	2,521.8
Delta (Asaba)	1,756.4	1,906.4	1,802.4	1,765.1	1,765.8
Ebonyi (Abakiliki)	–	–	–	–	–
Edo (Benin)	2,014.0	2,358.5	2,647.8	2,670.0	2,122.6
Ekiti (Ado-Ekiti)	114.6	109.7	–	–	–
Enugu (Enugu)	1,697.4	2,096.3	1,911.2	1,738.4	1,757.2
Gombe (Gombe)	975.5	955.4	833.6	985.9	857.4
Imo (Owerri)	2,247.2	2,350.2	2,362.1	2,818.0	2,738.0
Jigawa (Dutse)	–	–	–	–	–
Kaduna (Kaduna)	994.2	88.7	865.0	827.9	1,267.9
Kano (Kano)	114.7	109.1	113.1	109.0	–
Katsina (Katsina)	750.6	726.5	704.1	557.1	473.8
Kebbi (Birnin-Kebbi)	1,055.0	959.2	886.9	1,223.0	1,196.0
Kogi (Lokoja)	939.4	1,681.9	1,531.4	1,259.7	1,631.5
Kwara (Ilorin)	1,234.9	1,303.8	1,308.8	1,468.5	1,352.3
Lagos (Ikeja)	1,484.9	1,675.2	1,649.1	1,816.0	1,391.7
Nassarawa (Lafia)	1,290.7	1,320.1	1,569.6	10,718.8	1,566.0
Niger (Minna)	1,108.7	1,423.2	1,423.3	1,269.2	1,421.6
Ogun (Abeokuta)	924.2	1,142.1	876.2	1,371.7	1,465.5
Ondo (Akure)	1,317.1	1,381.0	1,405.7	1,466.1	1,309.6
Osun (Oshogbo)	1,130.2	1,469.7	1,421.7	1,597.6	1,277.7
Oyo (Ibadan)	1,192.0	1,260.2	1,218.8	889.4	1,702.1
Plateau (Jos)	1,203.5	1,248.4	1,357.2	1,259.8	1,236.9
Rivers (Port Harcourt)	2,055.2	2,868.6	2,865.2	1,606.6	2,601.6
Sokoto (Sokoto)	635.1	745.5	636.4	514.6	603.0
Taraba (Jalingo)	872.0	923.6	1,070.6	1,038.4	1,569.1
Yobe (Damaturu)	448.6	409.5	483.1	320.3	366.5
Zamfara (Gusau)	920.3	961.8	615.8	954.0	1,006.0
FCT, Abuja	1,471.8	1,311.6	1,388.9	1,174.7	1,444.6

Source: Nigerian Meteorological Agency [NBS; 2011]

TABLE A – 2:
POPULATION FORECAST FOR NIGERIA UP TO THE YEAR 2035

Year	Population (millions)	Population Growth Rate (%)	Median Age
1980	74		18.0
1985	84	2.6	17.5
1990	96	2.6	17.5
1995	108	2.5	17.7
2000	123	2.5	18.0
2005	140	2.6	18.0
2010	160	2.7	17.9
2015	184	2.8	17.7
2020	210	2.7	17.8
2025	240	2.7	18.1
2030	273	2.6	18.6
2035	310	2.5	19.2

Source: [UN; 2012]

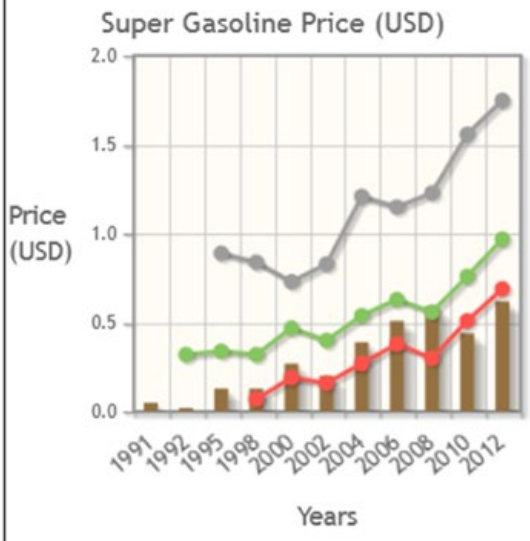
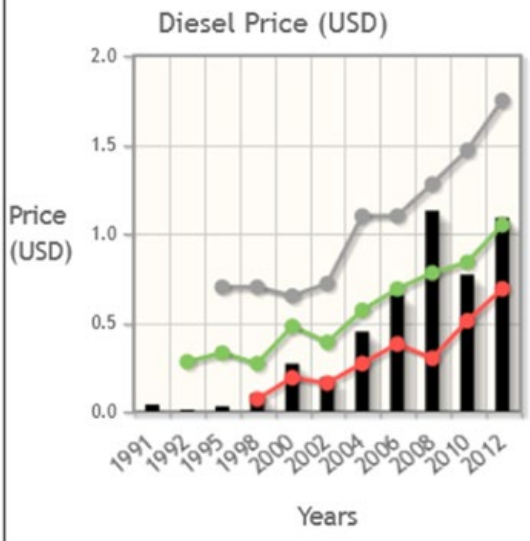
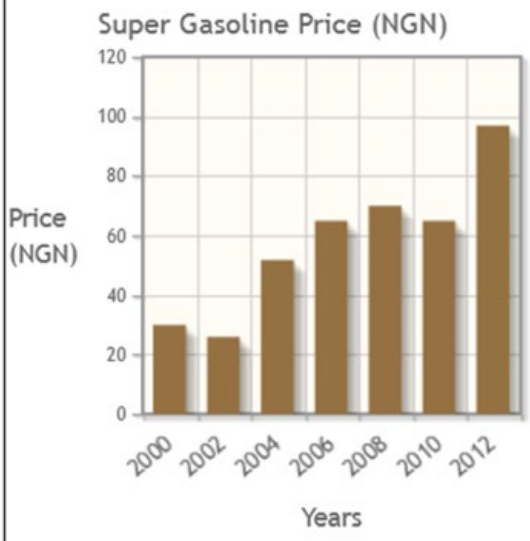
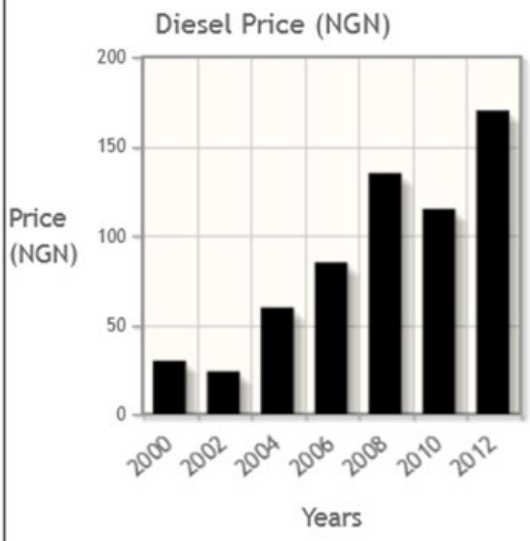
TABLE A – 3:
ECONOMIC GROWTH (AFTER RE-BASING)

%	2014a	2015b	2016b	2017b	2018b	2019b
GDP	6.2	5.6	6.5	6.9	7.3	6.8
Government consumption	9.0	10.0	7.0	6.5	7.0	7.5
Services	8.0	7.6	8.5	9.0	9.2	8.8
Private consumption	7.7	6.2	7.1	7.6	8.0	7.3
Domestic demand	7.3	6.3	6.8	7.2	7.7	7.2
Gross fixed investment	6.0	4.0	5.0	5.4	6.0	5.5
Industry	4.3	3.4	4.1	4.7	5.2	4.9
Agriculture	4.1	3.5	4.2	3.9	4.4	3.6
Imports of goods & services	2.7	3.4	3.5	5.2	6.4	6.5
Exports of goods & services	-3.1	-0.7	1.4	2.2	2.8	3.4

a Economist Intelligence Unit estimates. b Economist Intelligence Unit forecasts.
Source: [EIU; 2014]

12.2 Supplementary Information on the Energy Sector

FIGURE A–5:
FUEL PRICES IN NIGERIA

	Gasoline 95 Octane	Diesel
in USD*		
in Local Currency		

* benchmark lines: green=US price; grey=price in Spain; red=price of Crude Oil
Source: Energypedia

TABLE A–4:
ENERGY CONSUMPTION BY SOURCE (KTOE, 2011)

	Primary Energy Supply	Final Con-sumption	Primary Energy Supply	Final Con-sumption	Primary Energy Supply	Final Con-sumption	Primary Energy Supply	Final Con-sumption	Primary Energy Supply	Final Con-sumption
Energy source	**Nigeria**		**Bangladesh**		**Brazil**		**Indonesia**		**South Africa**	
Coal	20	20	912	698	15,431	8,296	31,476	11214	98,477	16,676
Crude Oil	6,012	0	1,534	0	97,992	0	49,807	1704	20,489	0
Oil Products	6,525	10,858	3,324	3,964	11,035	1,000,209	22,786	62720	572	24,321
Natural Gas	8,027	1,351	16,614	6,890	22,887	12,744	34,761	16650	3,794	1,631
Nuclear	0	0	0	0	4,081	0	0	0	3,519	0
Hydro	486	0	76	0	36,837	0	1,068	0	177	0
Geothermal, solar, etc.	0	0	0	0	653	420	16,112	0	82	72
Biofuels and Waste	97,255	94,682	8,836	8,836	77,912	56,939	52,998	52266	14,526	10,638
Electricity	0	2,036	0	3,194	3,086	39,280	0	13749	-264	17,790
Total	**118,325**	**108,947**	**31,294**	**23,581**	**270,028**	**217,889**	**209,009**	**158301**	**141,372**	**71,127**
toe per capita	**0.73**	**0.67**	**0.21**	**0.16**	**1.37**	**1.11**	**0.86**	**0.65**	**2.79**	**1.41**

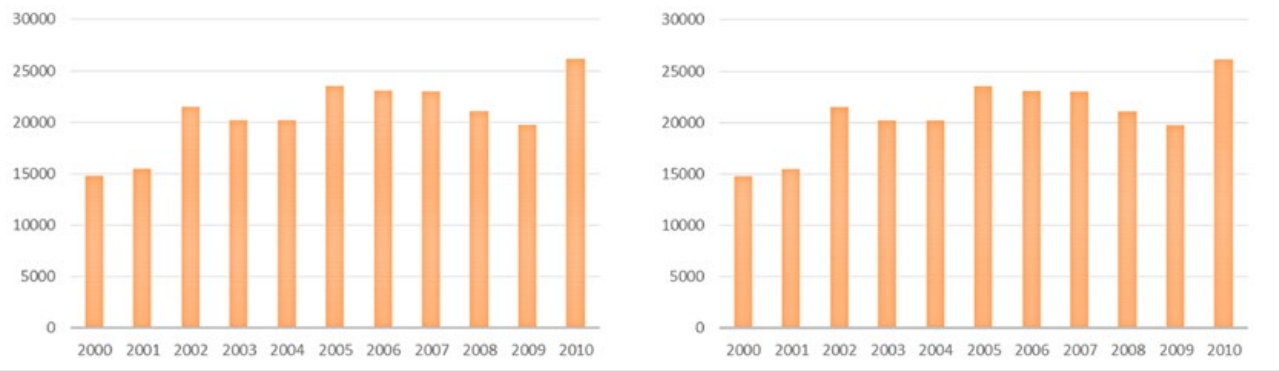
TABLE A–5:
MAIN SOURCES OF FUEL FOR COOKING

Source	Percentage
Fuel wood	69.8
Kerosene	26.6
Gas	1.11
Charcoal	0.84
Electricity	0.52
Crop residues/sawdust	0.09
Animal waste	0.07
Others	0.84

Source: Federal Ministry of Environment 2014 brochure on Scaling-up Renewable Energy Development 9n Nigeria, quoted from National Bureau of Statistics

12.3 Supplementary Information on the Power Sector

FIGURE A – 6:
NIGERIA ELECTRICAL ENERGY PRODUCTION (IN MILLION KWH)



Source: UN data base [62]

TABLE A – 6:
ELECTRICITY PRODUCTION AND CONSUMPTION FOR 2001 AND 2011 IN GWH

	Nigeria		Bangladesh		Brazil		Indonesia	
Production from	**2001**	**2011**	**2001**	**2011**	**2001**	**2011**	**2001**	**2011**
Coal	0	0	0	780	11163	12379	37713	81000
Oil	1099	4271	1172	2101	15818	14796	19627	42305
Gas	8455	17113	15227	40308	9921	25095	26220	37090
Biofuels	0	0	0	0	8980	32235	8	198
Waste	0	0	0	0	0	0	0	0
Nuclear	0	0	0	0	14279	15659	0	0
Hydro	5909	5650	993	872	267876	428333	11655	12419
Geothermal	0	0	0	0	0	0	6031	9371
Solar PV	0	0	0	0	0	0	0	1
Solar thermal	0	0	0	0	0	0	0	0
Wind	0	0	0	0	35	2705	0	0
Tide	0	0	0	0	0	0	0	0
Other sources	0		0	0	436	556	0	0
Total	15463	27034	17392	44061	328508	531758	101254	182384
Imports	0	0	0	0	37854	38430	0	0
Exports	0	0	0	0	-6	-2544	0	0
Domestic supply	15643	27034	17393	44061	366356	567644	101254	182384
Energy industry own use	442	774	977	2476	11154	2333	3710	6882
Losses	5987	2581	2413	4528	56628	8752	13024	16672
Final consumption	9034	23679	14002	37136	298575	456748	84520	159867
Industry	1987	3931	6017	21096	139406	209390	35593	53575
Transport	0	0	0	0	1200	2700	33340	0
Residential	4608	13568	6186	11956	73770	111971	33340	65884
Commercial and public services	2439	6180	1174	2474	71804	112227	15587	38608
Agriculture / forestry	0	0	392	1133	12395	21460	0	0
Fishing	0	0	0	3	0	0	0	0
Other non-specified	0	0	0	474	0	0	0	0

Source: [IEA; 2013]

TABLE A – 7:
LICENSEES OF THE NERC, APRIL 2015

Name	Type	Place	MW
Ikorodu Industrial Power Ltd	Embed-ded Genera-tion	Ikorodu, Lagos State	39.0
Island Power LImited		Marina,Lagos State	10.0
Kaduna Power Supply Company Limited		Kudenda Ind.Area, Kaduna	84.0
African Oxygen & Industrial Gases Limited	Generation off-grid	Ikorodu, Lagos State	19.0
Akute Power Limited		Lagos Water Corporation	13.0
CET Power Projects (Ewekoro)		Wapco Ewekoro, Ogun State	6.0
CET Power Projects Ltd.		Tinapa, Cross River State	20.0
CET Power Projects Ltd.		Nigerian Breweries Limited, Iganmu, Lagos	5.0
CET Power Projects(Sagamu)		WAPCO Sagamu, Ogun State	7.0
ContourGlobal Solutions (Nig) Ltd		NBC Bottling Plant, Ikeja	10.0
ContourGlobal Solutions (Nig) Ltd		NBC Bottling plant, Apapa	4.0
ContourGlobal Solutions (Nig) Ltd		NBC Bottling Plant, Benin	7.0
Coronation Power and Gas Limited		Sango Otta	20.0
DIL Power Limited		Cement factory, Ogun State	114.0
Energy Company of Nigeria Limited		Nestle,Agbara, Ogun State	3.0
Ewekoro Power Ltd		Ewekoro, Ogun State	12.5
Ilupeju Power Limited		Academy Press,Ilupeju	2.0
Income Electrix Limited		NPA, PH, Rivers State	6.0
PZ Power Company Limited		PZ Cussons Aba Factory, Abia State	4.0
Shoreline Power Company Limited		Lafarge Wapco, Sagamu, Ogun	9.0
Tower Power Abeokuta Limited		Abeokuta, Ogun State	20.0
Tower Power Utility Limited		Ota Industrial Estate, Ota, Ogun State	20.0
Unipower Agbara Limited		Unilever, Agbara, Ogun St.	6.0
Wedotebary Nigeria Limited		Kuru, Jos	5.0
AES Nigeria Barge Limited			270.0
Afam Power Plc		Afam, Rivers State	987.2
Agbara Shoreline Power Limited		Agbara, Ogun	100.0
Alaoji Generation Co. Ltd (NIPP)		Alaoji, Abia State	1,074.0
Anita Energy Limited		Agbara, Lagos State	90.0
Azura Power West AFrica Limited		Ihovbor Benin, Edo State	450.0
Benin Generation Company Limited		Ihonvbor, Edo State	450.0
Calabar Generation Company Limited		Calabar, Cross Rivers State	561.0
Century Power Generation Limited		Okija, Anambra State	495.0
Delta Electric Power Limited		Oghareki, Etiope West LGA	116.0
DIL Power Plc		Obajana, Kogi State	135.0
Egbema Generation Company Limited		Egbema Imo State	338.0
Egbin Power Plc		Egbin, Lagos State	1,320.0
Eleme Petrochemical Company Limited		Eleme Complex,P.H Rivers	135.0
Energy Company of Nigeria (NEGRIS)		Ikorodu, Lagos State	140.0
Enersys Nigeria Limited		Ado-Ekiti, Ekiti State	10.0
Ethiope Energy Limited		Ogorode, Sapele, Delta State	2,800.0
Farm Electric Supply Ltd		Ota, Ogun State	150.0
First Independent Power Co. Ltd		Omoku, Rivers State	150.0
First Independent Power Co. Ltd		Trans-Amadi, Rivers State	136.0
First Independent Power Co. Ltd		Eleme, Rivers State	95.0
Fortune Electric Power Co. Ltd		Odukpani, Cross River State	500.0

Name	Type	Place	MW
Gbarain Generation Company Limited	Generation off-grid	Gbarain, Bayelsa State	225.0
Geometric Power Ltd		Aba, Abia State	140.0
Geregu Generation Company Limited		Geregu II, Kogi State	434.0
Geregu Power Plc (BPE)		Geregu, Kogi State	414.0
Hudson Power Limited		Warawa, Ogun State	150.0
Ibafo Power Station Limited		Ibafo, Ogun State	200.0
Ibom Power Ltd		Ikot Abasi, Akwa Ibom State.	190.0
ICS Power Ltd		Alaoji, Abia State	624.0
Isolo Power Generation Limited		Isolo Lagos State	20.0
JBS Wind Power Limited		Maranban Pushit, Mangu, Plateau State	100.0
Kainji Hydro Electric Plc (Jebba Station)		Jebba, Niger State	570.0
Kainji Hydro Electric Plc (Kainji Station)		Kainji, Niger State	760.0
Knox J&L Energy Solutions Limited		Ajaokuta, Kogi State	1,000.0
Lotus & Bresson Nigeria Limited		Magboro, Ogun State	60.0
Mabon Ltd		Dadinkowa, Gombe State	39.0
MBH Power Limited		Ikorodu, Lagos State	300.0
Minaj Holdings Ltd		Agu-Amorji Nike, Enugu East LGA, Enugu State	115.0
Nigerian Agip Oil Co. Ltd		Okpai, Delta State	480.0
Nigerian Electricity Supply Corporation (Nigeria) Limited (NESCO)		Bukuru, Plateau State	30.0
Notore Power Ltd		Onne, Rivers State	50.0
Ogorode Generation Co. Ltd (NIPP)		Ogorode,Delta State	450.0
Olorunshogo Generation Co. Ltd (NIPP)		Oluronshogo, Ogun State	750.0
Olorunsogo Power Plc (BPE)		Olorunsogo, Ogun State	335.0
Omoku Generation Company Limited		Omoku, Rivers State	250.0
Omotosho Generation Company Limited		Omotosho II, Ondo State	500.0
Omotosho Power Plc (BPE)		Omotosho, Ogun State	335.0
Paras Energy & Natural Resources Development Limited		Ogijo, Ogun State	96.0
Sapele Power Plc		Sapele, Delta State	1,020.0
Shell Petroleum Dev. Co. Ltd		Afam VI,	642.0
Shiroro Hydro Electricity Plc		Shiroro, Niger State	600.0
Supertek Electric Limited		Ajaokuta, Kogi State	500.0
Supertek Nig. Ltd		Akwete, Abia State	1,000.0
Ughelli Power Plc		Ughelli, Delta State	942.0
Westcom Technologies & Energy Services Ltd.		Sagamu, Ogun State	1,000.0
Zuma Energy Nigeria Ltd (Gas Plant)		Ohaji Egbema, Owerri, Imo	400.0
Zuma Energy Nigeria Ltd(Coal Plant)		Itobe, Kogi State	1,200.0
Total			**26,868.7**

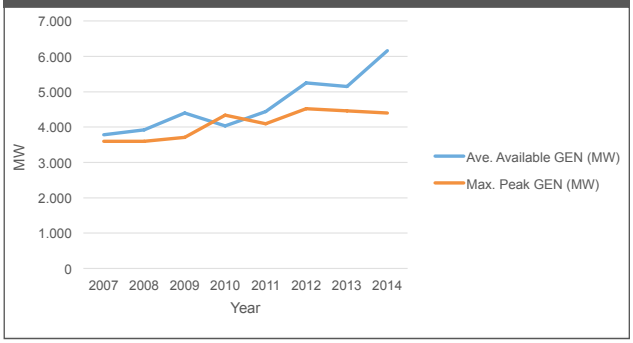
Source: NERC, [36]

TABLE A–8:
EXISTING NIGERIAN POWER PLANT FLEET, 2015

Name	Fuel Type	Year Completed	Installed Capacity (MW)	Installed Available Capacity (MW)	Actual Generation Capacity (MW) as of May 2015*
AES	Gas	2001	270	267	0
AFAM IV-V	Gas	1982	580	98	0
AFAM VI	Gas	2009	980	559	523
ALAOJI NIPP	Gas	2015	335	127	110
DELTA	Gas	1990	740	453	300
EGBIN	Gas	1985	1320	931	502
GEREGU	Gas	2007	414	282	138
GEREGU NIPP	Gas	2012	434	424	90
IBOM POWER	Gas	2009	142	115	92
IHOVBOR NIPP	Gas	2012	450	327	225
JEBBA	Hydro	1986	570	427	255
KAINJI	Hydro	1968	760	180	181
OKPAI	Gas	2005	480	424	391
OLORUNSOGO	Gas	2007	335	244	232
OLORUNSOGO NIPP	Gas	2012	675	356	87
OMOKU	Gas	2005	150	0	0
OMOTOSHO	Gas	2005	335	242	178
OMOTOSHO NIPP	Gas	2012	450	318	90
RIVERS IPP	Gas	2009	136	166	0
SAPELE	Gas	1978	900	145	81
SAPELE NIPP	Gas	2012	450	205	116
SHIRORO	Hydro	1989	600	480	350
ODUKPANI	Gas	2013	561	70	0
Total			**12,067**	**6,840**	**3,941**

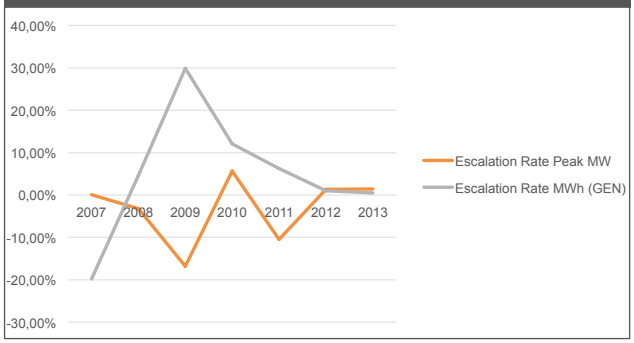
Source: NERC
* Discrepancy to installed available capacity mainly due to gas shortage

FIGURE A–7: AVERAGE AVAILABLE GENERATION AND MAXIMUM PEAK GENERATION (2007–2014)



Source: NERC Archive

FIGURE A–8: VARIATIONS IN PEAK MW AND MWH GENERATION (YEAR-ON-YEAR)



Source: Own calculations based on NERC Archive

TABLE A – 9:
NERC CLASSIFICATION FOR DISCO PRICING

Customer Classification	Description	Remarks
Residential		
R1	Life-Line (50 kWh)	A consumer who uses his premises excl. as a residence
R2	Single and 3-phase	
R3	LV Maximum Demand	
R4	HV Maximum Demand (11/33 KV)	
Commercial	**A consumer who uses his premises for any purpose other than exclusively as a residence or as a factory for manufacturing goods**	
C1	Single and 3-phase	
C2	LV Maximum Demand	
C3	HV Maximum Demand (11/33 KV)	
Industrial	A consumer who uses his premises for manufacturing goods including welding and ironmongery	
D1	Single and 3-phase	
D2	LV Maximum Demand	
D3	HV Maximum Demand (11/33 KV)	
Special	**Customers such as agriculture and agro-allied industries, water boards, religious houses, government and teaching hospitals, government research institutes and educational establishments.**	
A1	Single and 3-phase	
A2	LV Maximum Demand	
A3	HV Maximum Demand (11/33 KV)	
Street lighting		
S1	Single and 3-phase	

TABLE A – 10:
NERC: DISCO PRICING ACCORDING TO MYTO 2.1, UPDATED TARIFFS – SELECTED DISCOS (2015)

Customer Classification	Abuja DISCO – Naira/KWh	Jos DISCO – Naira/KWh
Residential		
R1	4.00	4.00
R2	19.96	20.18
R3	32.25	35.70
R4	32.25	35.70
Commercial		
C1	23.61	25.94
C2	29.98	33.18
C3	29.98	33.18
Industrial		
D1	24.19	25.94
D2	31.43	34.78
D3	31.43	34.78
Special		
A1	23.16	25.63
A2	23.16	25.63
A3	23.16	25.63
Street lighting		
S1	19.11	24.70

12.4 Supplementary Information on Renewable Energy, Energy Efficiency and Rural Electrification

TABLE A – 11:
COMPONENTS STANDARDS ELABORATED / ADAPTED / ADOPTED BY SON

Code	Description
NCP 031:2010ET:	Code of practice for the deployment of outdoor solar lighting systems
NIS IEC 60061:	Lamp caps and holders together with gauges for the control of interchangeability and safety
NIS IEC 60061-1:	Lamp caps and holders together with gauges for the control of interchangeability and safety – Part 1: Lamp caps
NIS IEC 60061-3:	Lamp caps and holders together with gauges for the control of interchangeability and safety – Part 3: Gauges
NIS IEC 60081:1984	Tubular fluorescent lamps for general lighting services
NIS IEC 60238	Edison screw lamp holders
NIS IEC 60360	Standard method of measurement of lamp cap temperature rise
NIS IEC 60364-7-712:	Electrical installations of buildings – Part 7 – 712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems
NIS IEC 60695-2-10:2000	Fire hazard testing – Part 2 – 10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure
NIS IEC 60695-2-11:2000	Fire hazard testing – Part 2 – 11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end products D NIS 748:2012
NIS IEC 60695-2-12:2010	Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability test method for materials
NIS IEC 60695-2-13:2010	Fire hazard testing – Part 2 –13: Glowing/hot-wire based test methods – Glow-wire ignitability test method for materials
NIS IEC 60901	Single-capped fluorescent lamps – Performance specifications
NIS IEC 60968:1988	Self-ballasted lamps for general lighting services – Safety requirements
NIS IEC 61215:2005	Crystalline Silicon Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval
NIS IEC 61427:2005	Secondary cells and batteries for Photovoltaic Energy Systems (PVES) – General requirements and methods of test
NIS IEC 61646:2008	Thin-film Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval
NIS IEC 61683:1999	Photovoltaic systems – Power conditioners – Procedure for measuring efficiency Standards for safety and performance of CFLs
NIS IEC 61730 2004-1:	Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction
NIS IEC 61730 2004-2:	Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing
NIS IEC 62109:2010	Safety of Power Converters for use in Photovoltaic Power Systems – Part 1: General Requirements
NIS IEC 62109:2010	Safety of Power Converters for use in Photovoltaic Power Systems – Part 2: Particular requirements for inverters

TABLE A – 12:
NREEEP BIOMASS AND WIND TARGETS

Activity / Item	Timeline / Quantity		
	Short Term (2015)	Medium Term (2020)	Long Term (2030)
Biomass electricity (MW)	5	57	292
Biofuel (ML/day) • Bio ethanol (B10) • Biodiesel (B20)	 5.3 2.0	 9.7 3.4	 24.2 11.7
Wind electricity (MW)	55	631	3,211
Windmill water pumping systems (no.)	20	100	200

Source: NREEEP

TABLE A – 13:
NREEEP SOLAR AND HYDROPOWER TARGETS

Activity / Item	Timeline / Quantity		
	Short Term (2015)	Medium Term (2020)	Long Term (2030)
Solar – All PV and Solar Thermal (MW)	117	1,343	6,831
Large hydropower (MW)	2,121	4,549	4,627
Small hydropower (MW)	140	1,607	8,174

Source: NREEEP

TABLE A – 14:
NREEEP RENEWABLE ELECTRICITY SUPPLY PROJECTION IN MW

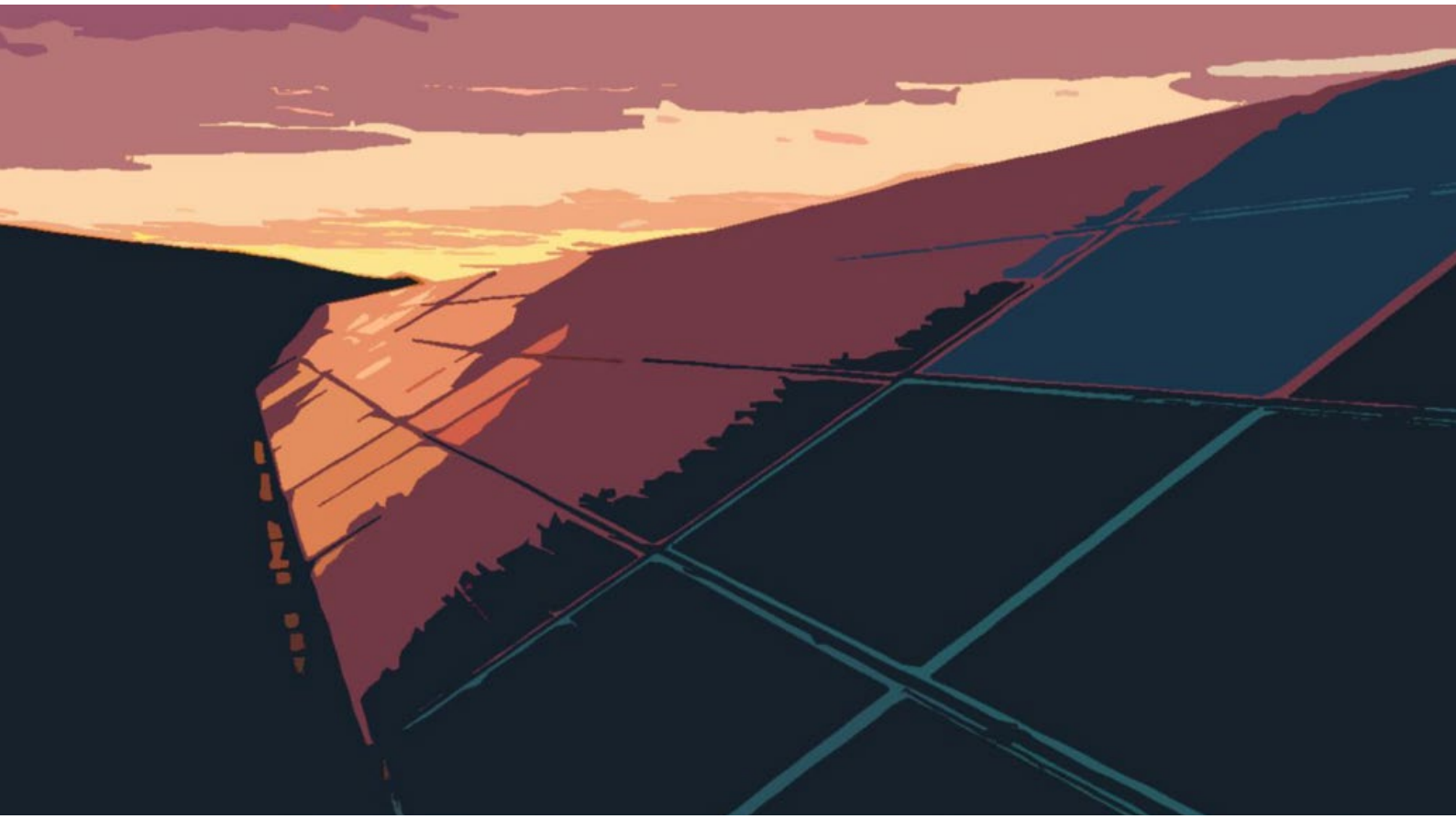
Resource	to date	Short Term*	Medium Term*	Long Term*
All renewables plus LHP	1,985.18	2,438	8,188	23,135
All energy resources	21,200	24,380	45,490	115,674
% of Renewables	23%	10%	18%	20%
% RE Less large Hydropower (LHP)	0.8%	1.3%	8%	16%

* CBN, NPC: Short Term: 2013 – 2015; Medium Term: 2016 – 2020; Long Term: 2021 – 2030
From supply projections based on 13% GDP growth
Source: NREEEP

TABLE A – 15:
INVESTMENT OPPORTUNITIES FOR SMALL HYDRO POWER DEVELOPMENT IN NIGERIA

No.	Project Name	Project Location: Town / L.G.A. / State	Head [m]	Design Potential [KW]	Date of Detailed Project Report (DPR*)	Project Design Cost (Implementation Cost)		Funding Source of DPR	Benefiting Communities
						NGN	US$		
1.	Eficghim Waterfall Small Hydro Power project	Ajassor / Etung / Cross River	11.98	200	Aug. 2007	98,950,820.58	659,672.14	Rural Electrification Agency, Nigeria	Ajassor – Rural Population
2.	Erin Ijesa Small Hydro Power project	Erin Ijesa / Oriade / Osun	75.88	764.59	Aug. 2008	151,352,394.10	1,009,015.96	Ministry of Work and Transport	Erin Ijesa, Erin Oke – peri-urban population
3.	Okinni Dam SHP project	Okinni / Egbedore / Osun	20.0	1,900	March 2008	228,810,443.00	1,525,402.90	Min. of Water Resources and Rural Development	Okinni – peri-urban population
4.	Ikeji-Ile Ijesa SHP project	Ikeji Ile Ijesa / Oriade / Osun	32.0	78.94	Aug. 2008	76,688,515.76	511,256.76	Min. of Water Resources & Rural Development	Ikeji Ile - Ijesa, Ira – peri-urban population
5.	Doma Dam SHP project	Doma / Doma / Nasarawa	27.0	450	Feb. 2008	89,077,549.14	593,850.33	Ministry of Water Resources and Rural development.	Eza, Amaku, Alage and Yelwa – peri-urban population
6.	Amoke / Ugbokpo SHP project.	Amoke-Ugbokpo / Apa / Benue	7.0	1,225	July, 2009	486,918,913.43	3,246,126.09	1. UNIDO Country Office 2. Benue State Government 3. Fed Government Nigeria	Ugbokpo and Amoke – peri-urban population
7.	Pico-Hydro power (OOPL Complex) SHP	Abeokuta / Abk South / Ogun	2.6	17.0	Nov. 2009	13,477,193.9	89,847.95	UNIDO Country Office	Olusegun Obasanjo Pres. Library Complex – Urban population
8.	Kabomo River Valley SHP as Mini Grid Base R.E to support Rural Electrification	Kabomo / Bakori / Katsina		370	Jan. 2010	194,818,566	1,298,790	UNIDO-GEF	Ungwan Dogo, Galadima, Dindile, Tudunwada and Kabomo – peri-urban population
9.	Zobe Dam, SHP	Dutsin-Ma / Katsina	5.53	291.0	July 2011	60,652,930.0	404,352.87	Fed. Govt. of Nigeria	Dutsin – Ma; Rural population
10.	UNICAL SHP	UNICAL / Calabar, Cross River	2.7	6,500.0	June, 2011	2,602,036,882.0	17,346,912.55	UNICAL	UNICAL; Peri-urban population
11.	Balanga Dam SHP	Balanga / Balanga / Gombe	8.0	720.0	Sept. 2011	149,103,942.36	994,026.28	Gombe State Government	Balanga; Rural population
12.	Tunga Dam SHP	Kakara / Mambilla, Taraba	90.0	400.0	2006	26,595,220.6	177,301.47	UNHCR and UNIDO	UNHCR and UNIDO

Source: UNIDO, 1980



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