



Federal Republic of Nigeria

***DRAFT***

# **THE NIGERIAN POWER SECTOR INVESTMENT OPPORTUNITIES AND GUIDELINES**

**JUNE 2016**



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I also acknowledge the support, encouragement and contributions of the Permanent Secretary (Power) **Louis Edozien**, for his guidance, direction and editing of the document. This document is expected to close the information gap that had hitherto existed to prospective investors and will also be a marketing instrument to the Investment and Sector Development Department and the Ministry in general.

The Team expresses its gratitude to all relevant stakeholders and some selected investors, who supplied valuable and informative materials that made up this document. It is a real pleasure and treasured opportunities for the exchange of ideas and to learn from highly experienced representatives of the following stakeholders:

- Nigerian Bulk Electricity Trading Company (NBET);
- Transmission Company of Nigeria (TCN);
- Nigeria Electricity Regulatory Commission (NERC);
- Infrastructure Concession Regulatory Commission (ICRC);
- Nigerian Electricity Management Services Agency (NEMSA);
- Nigerian National Petroleum Corporation (NNPC);
- Energy Commission of Nigeria (ECN);
- Gas Association Company of Nigeria (GACN).
- Federal Ministry of Water Resources (FMWR);

- Federal Ministry of Solid Minerals Development (FMSMD); and
- Federal Ministry of Environment (FMEnv.)

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## **FOREWORD**

What you are holding in your hand is a document of many purposes and indeed some welcome coincidences.

It was conceived in January 2016, first as a document to guide the implementation of Nigeria's energy policy, and to optimize its many fuel sources of Hydro, Coal, Solar, wind and Gas for energy production.

In effect it was to help bring power production closer to fuel and feedstock sources in order to make power more affordable.

Secondly, it was to serve as a planning tool, not only to guide investment in power production and generation but to assist the Transmission Company plan and concentrate its evacuation resources and put an end to incidents of stranded power.

Between conception in January 2016 and conclusion in June 2016, our vulnerability to over dependence on gas had become apparent. 23 (twenty-three) out of 26 (twenty-six) power plants in the country depend on Gas.

Between February 14, 2016 and June 2, 2016, there have been 14 (fourteen) incidents of oil and gas pipeline and platform vandalizations.

Therefore, this document is also a solution to that vulnerability the roadmap to energy diversity and security.

It reveals our alternatives to Gas and our commitment to pursue those alternatives.

I am delighted to contribute this foreword.

**Babatunde Raji Fashola, SAN**

Honourable Minister of Power, Works and Housing

## CHAPTER I

### **1.0 INTRODUCTION**

#### **1.1.1 Background**

Nigeria's Population is the seventh largest in the World with 193.4 million people. The country represents over 65% of the effective West African market and remains the most competitive destination for the establishment of medium and large manufacturing industries.

#### **1.1.2 Geography and Population Distribution**

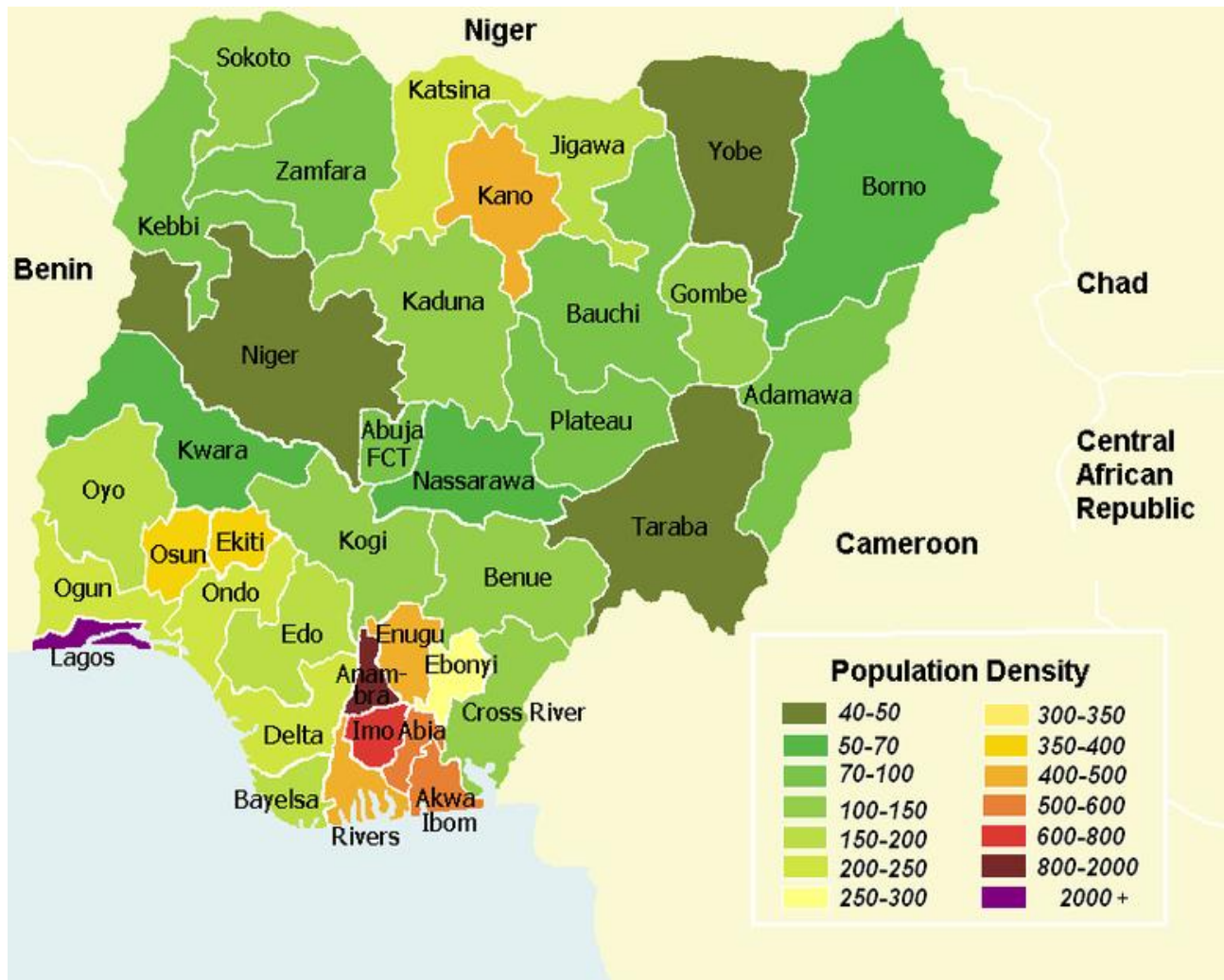
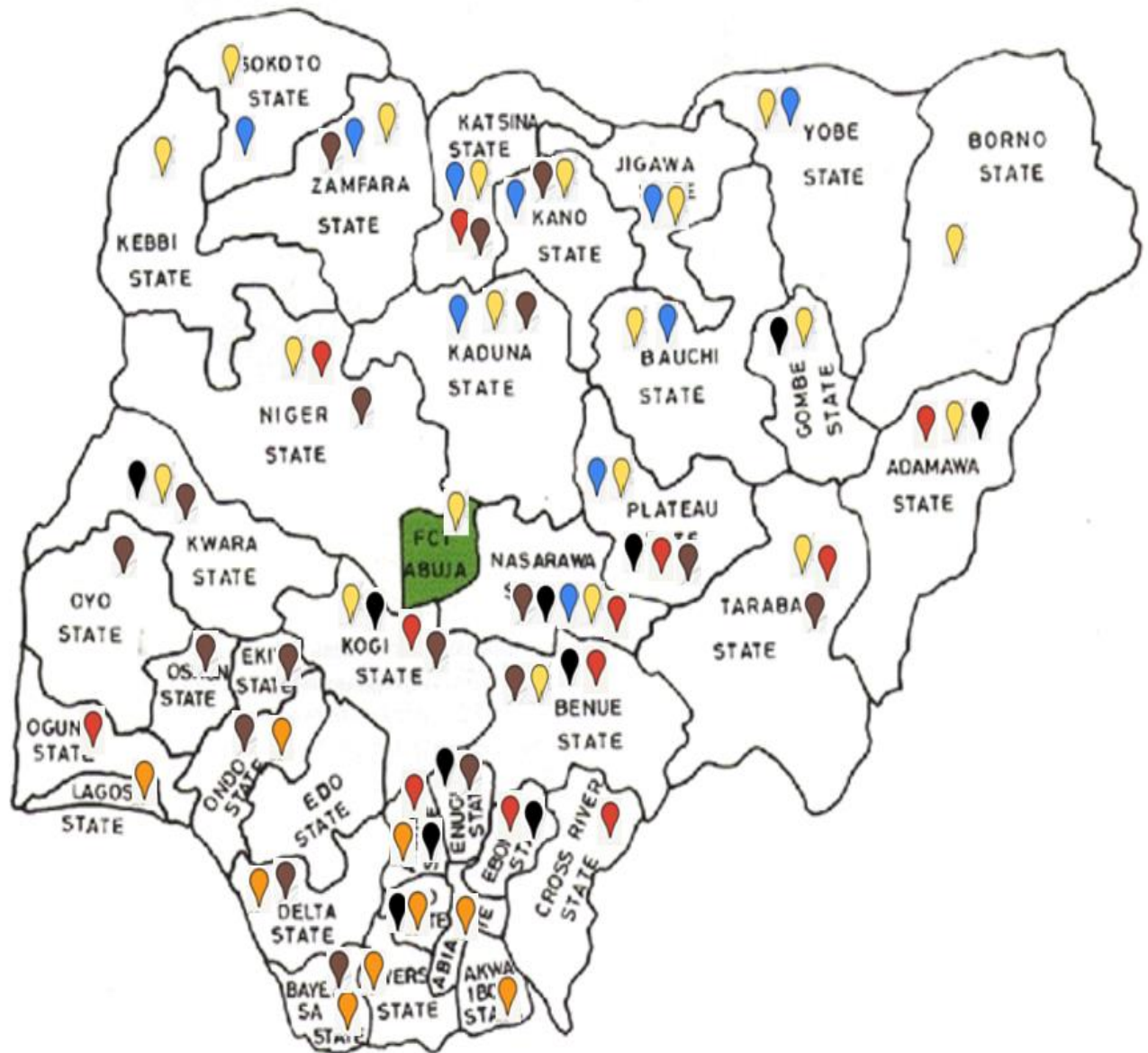


Fig. 1: Map of Nigeria showing geographical location and population distribution





Gas	Small Hydro	Coal
Solar	Wind	Large Hydro

Fig. 2: Nigeria energy resources distribution Map

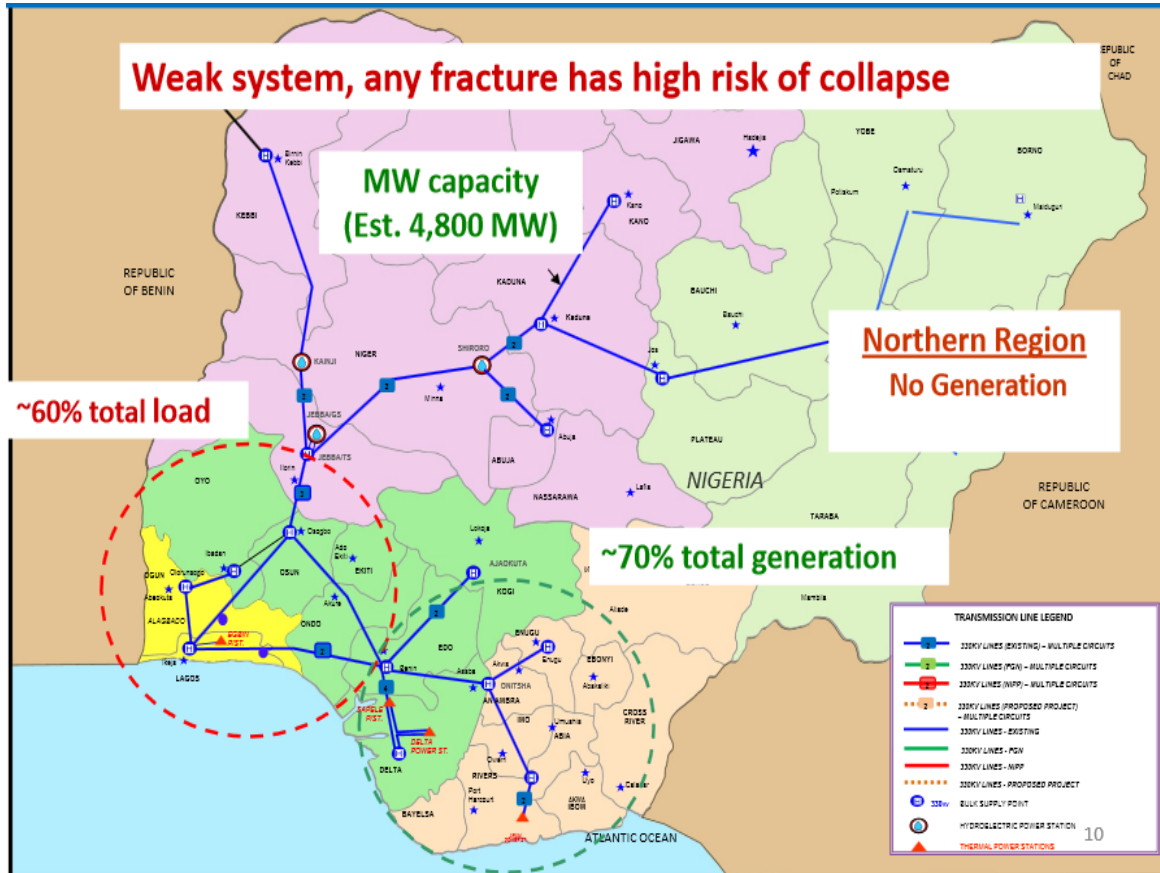


Fig 3: Map of existing power infrastructures between generation and transmission

### 1.1.3 Nigeria's Energy Statistics and Economic Indicators

Total Energy Consumption	1,259TWhr/annum	Area:	923,770sq. km
Total Electricity Production	19.78TWhr/annum	Rural Population:	52%
Energy consumption/capita	8.1 MWhr/head	GDP:	US\$262.6bn (2012)
Electricity Consumption	18.05TWhr	GDP Growth:	Ave. 7% for last 3yrs
Access to Electricity (National)	54 %	GND per capita:	US\$2,300 approx
Access to Electricity – rural	28%		

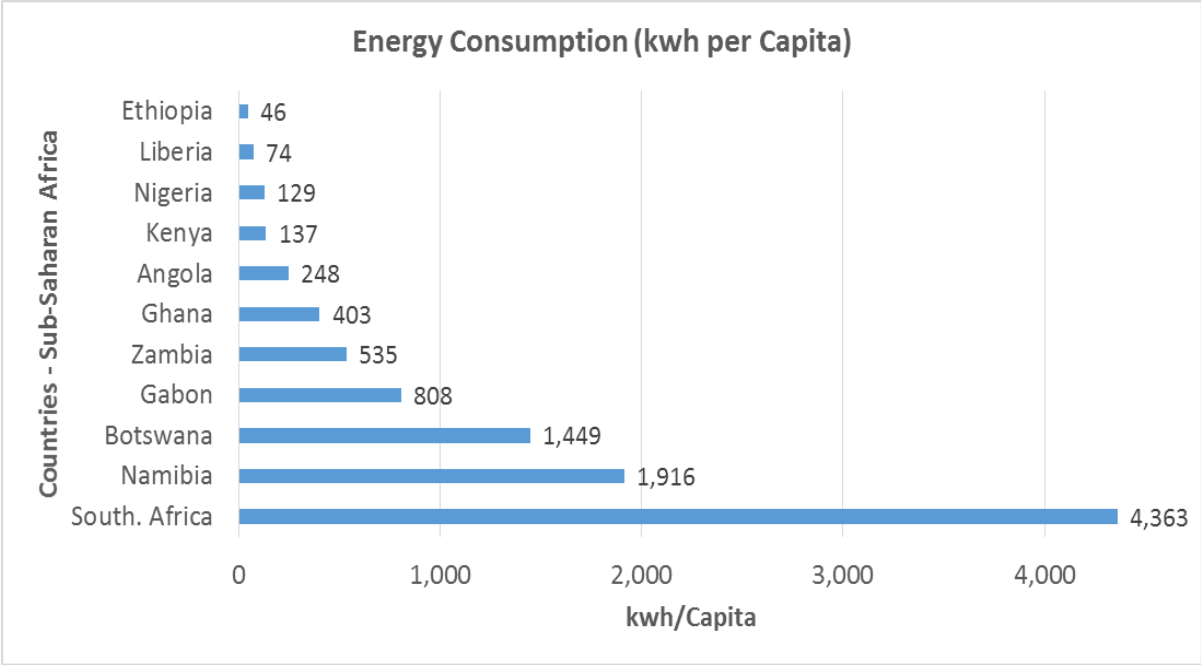
*\*NBS 2012*

#### 1.1.4 Nigeria Energy Situation compared with selected countries

Table 1

Country	Population (Million)	Generation Capacity (GW)	Energy Consumption (billion kwh)	Energy Consumption per Capita (kwh)
USA	321,368,864	1,053	3,883	12,083
Germany	80,854,408	178	583	7,204
UK	64,088,222	76	304	4,740
South. Africa	53,675,563	44	234	4,363
China	1,367,485,388	1,505	5,523	4,039
Brazil	204,259,812	119	479	2,344
Egypt	88,487,396	27	129	1,462
Indonesia	255,993,674	41	156	609
India	1,251,695,584	223	758	605
Ghana	26,327,649	3.0	11	403
<b>Nigeria</b>	<b>178,562,056</b>	<b>7.6</b>	<b>23</b>	<b>129</b>

*\*CIA fact book, 2014*



*\*CIA fact book, 2014*

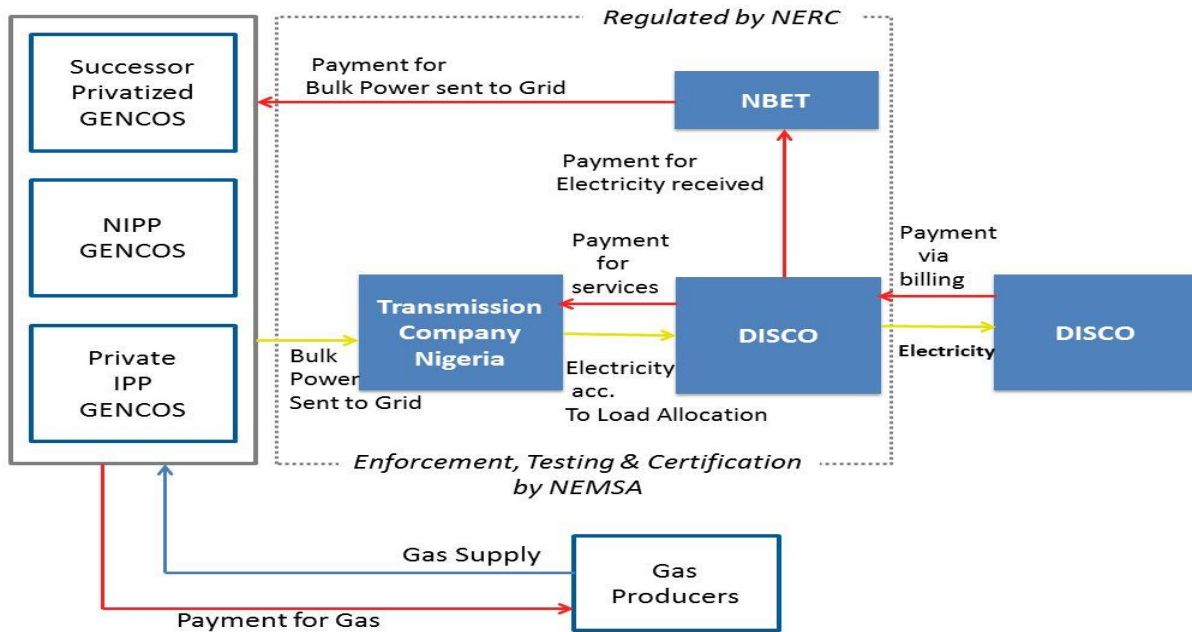
Fig. 4: Nigeria Energy Situation compared with selected countries

**1.2 Overview of the Nigerian Power Sector**

The Nigeria power system is characterized by huge gap between supply and demand; current power demand is estimated at 17,520MW including latent and suppressed demand, against 5,300MW peak generation. As a result, about 90 million Nigerians have been reported to have no access to electricity according to (African Progress Report 2015). Out of this non-electrified population, 17 million people live in urban areas, while 73 million live in rural areas. The country targets 10.2MW by 2019 and by 2030 including all energy mix for electricity generation. In order to achieve this, massive investments are expected in the power value chain.

**1.3 Nigeria’s Power Sector Reforms**

In order to attract investment into the sector, the Federal Government in 2005 enacted the Electricity Power Sector Reform (EPSR) Act which liberalized and commercialized and privatized the electricity sector.



#### 1.4 Nigeria's Power Sector Potentials

Nigeria is well endowed with resources in both renewable and non-renewable energies which could sufficiently address existing power shortages and promote the Federal Government's drive to attain sufficiency in power supply in the year 2030 and beyond. . As it stands, Nigeria's main energy carrier is biomass (81.25%), followed by natural gas (8.2%), petroleum products (5.3%), crude oil (4.8%), hydropower (0.4%), and others (< 1%).

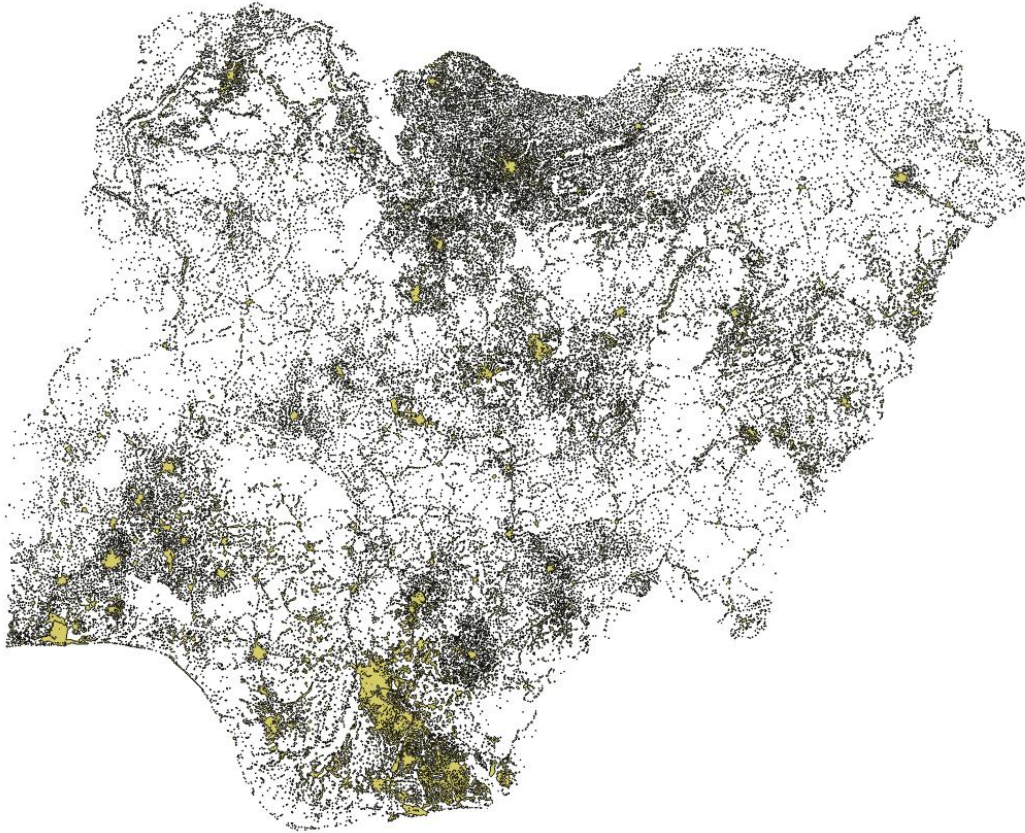


Fig 5: Geographical Distribution of Nigeria Population Clusters

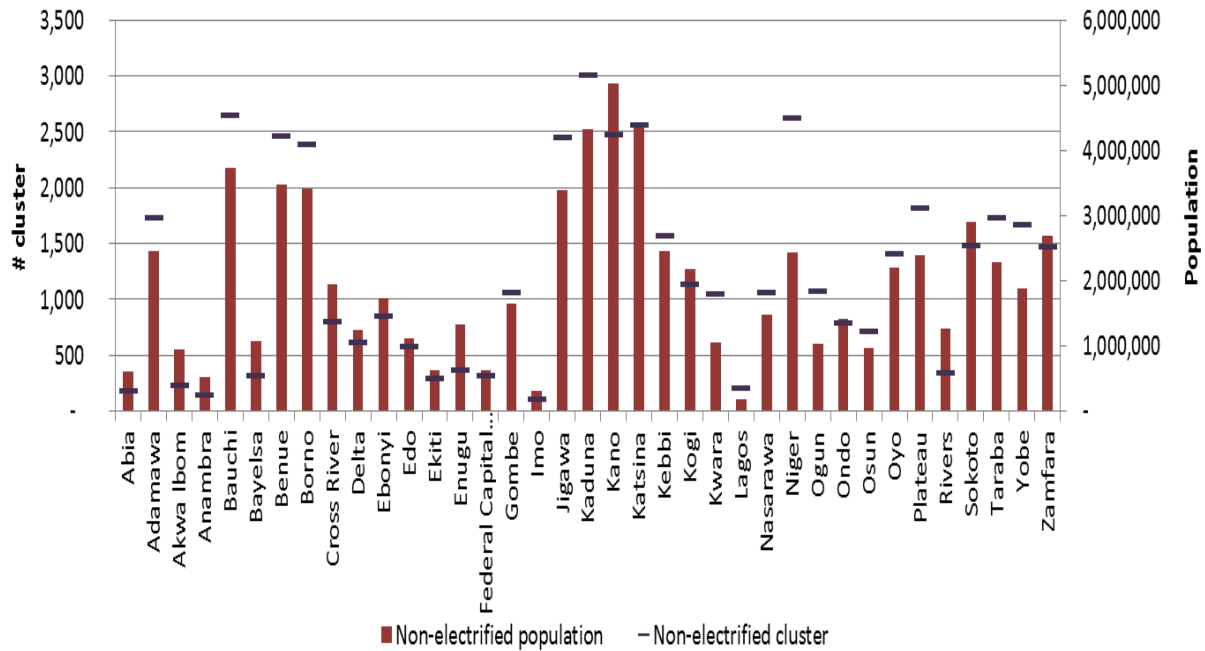


Fig. 6: Statistics of Non-electrification Population Clusters per State



A recent study by GIZ/FMoP identified a total of 47,489 population clusters spread across the country. It was also established that out of the population of 193.4 million people (NPC 2016), 174 million live within the clusters. Also, about 10% of population is assumed to live in very small settlements or have no permanent settlement locations.

Of the identified clusters, a total of 45,456 clusters are considered to be non-electrified (95 %). Although this represents the vast majority of clusters, only 89 million people out of 193.4 million people (46 %) live in the electrified area.

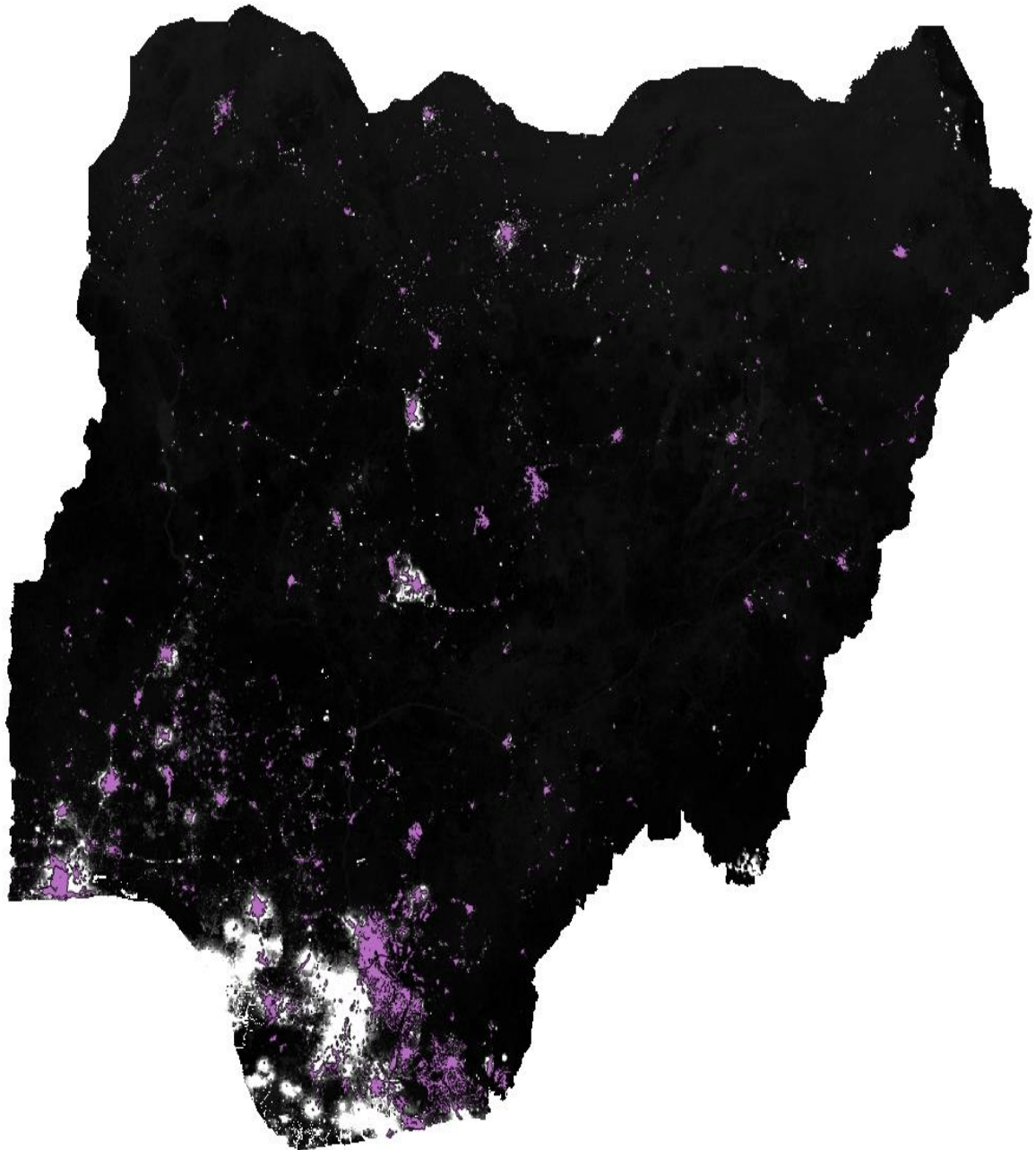


Fig. 7: Geographical Distribution of Electrification

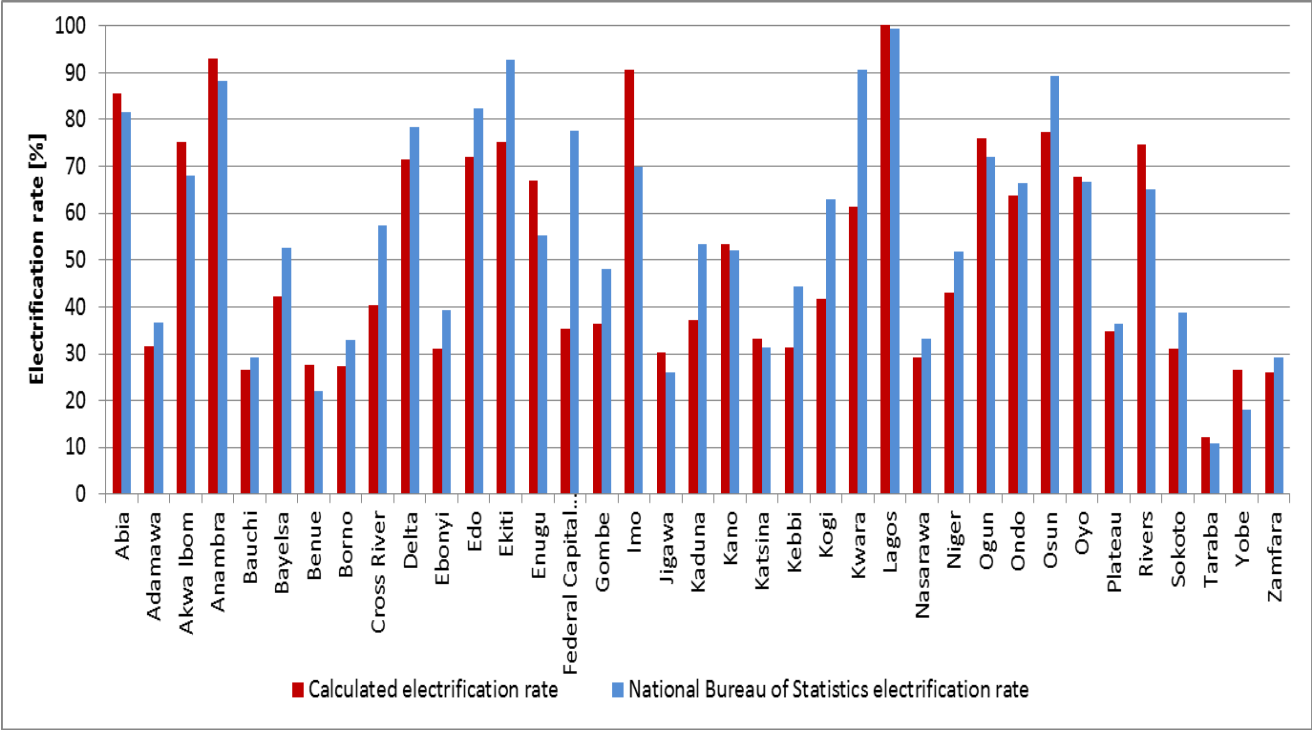


Fig. 8: Electrification Rate per State

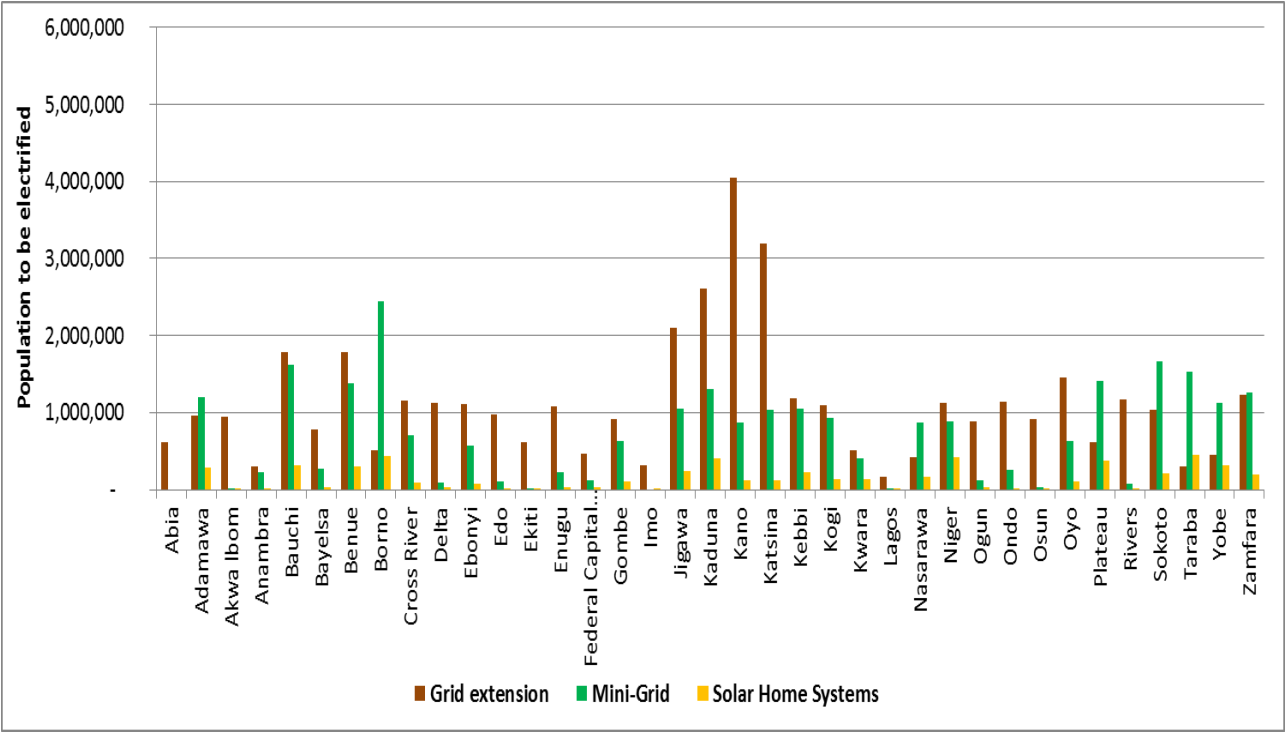


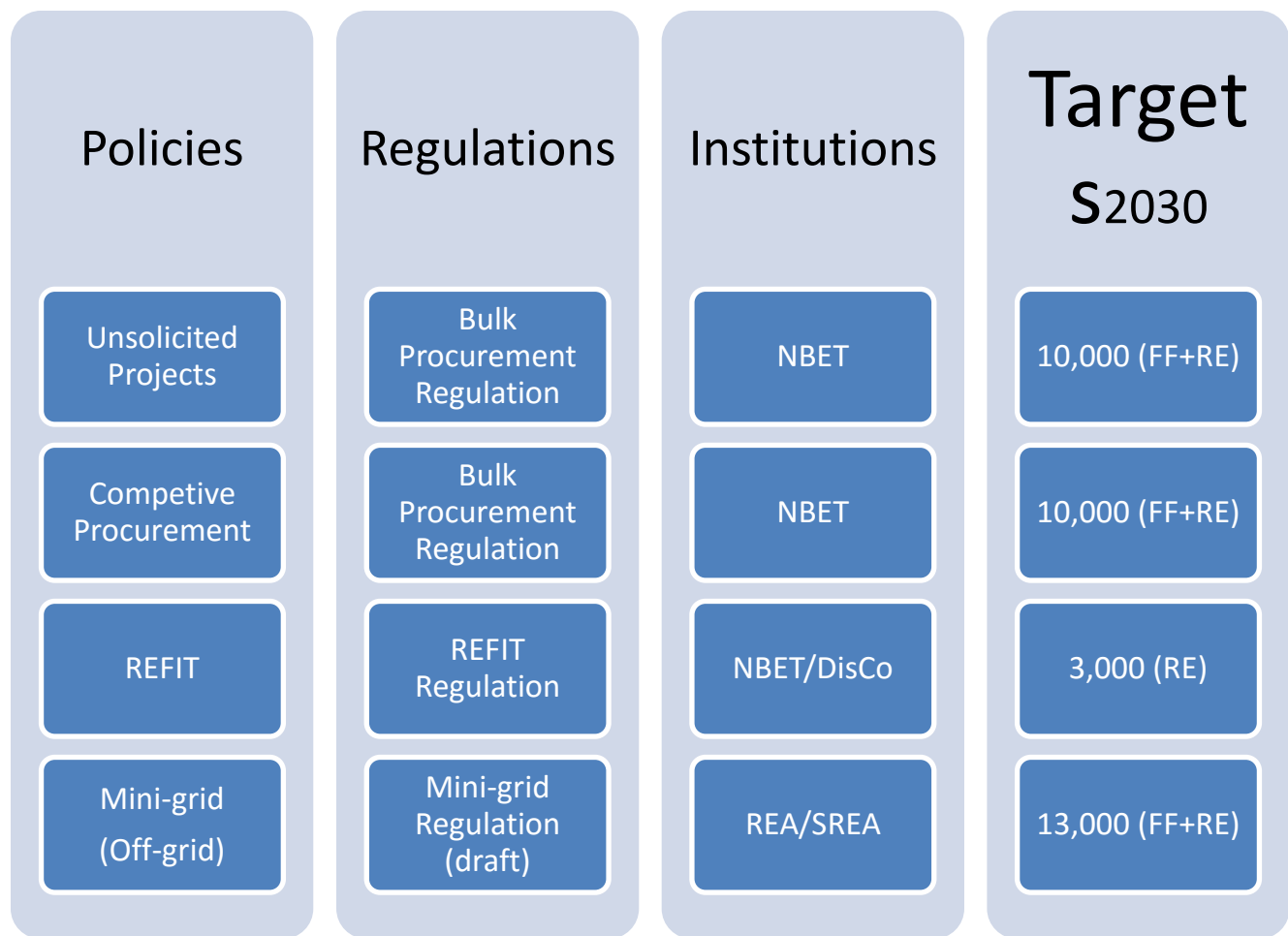


Fig.9: Electrification Options per State

### **1.5 HIGHLIGHTS OF ENERGY POLICIES IN NIGERIA**

The approved and draft Energy Policies are stated below for harnessing the Nigeria energy potentials:

<b>Approve National Energy Policies</b>	<b>Draft Energy Policies</b>
<b>National Electric Power Policy (NEPP) – 2001</b>	Renewable Energy Master Plan (REMP) 2013
<b>Nigeria Energy Policy (NEP) - 2003</b>	National Renewable Energy Action Plan (NREAP) 2015
<b>Electric Power Sector Reform Act (EPSR) – 2005</b>	National Energy Efficiency Action Plan (NEEAP) 2015
<b>Rural Electrification Policy Paper (REPP) – 2009</b>	Sustainable Energy for All - Action Agenda (SE4All-AA) 2015
<b>The Roadmap for Power Sector Reform 2010</b>	
<b>Nigeria Electricity Management Services Act – 2015</b>	



## **CHAPTER II**

### **2.0 CURRENT STATUS OF ELECTRICITY AND DESIRED ENERGY MIX**

#### **2.1 Present Energy Mix (MW) - Generation**

On average, the nation has generation capability of 5,700MWH/H, 86% of this capability is from gas-fired thermal power stations. The remaining 14% is from the three large hydroelectric power stations. The figure below shows the present capacity.

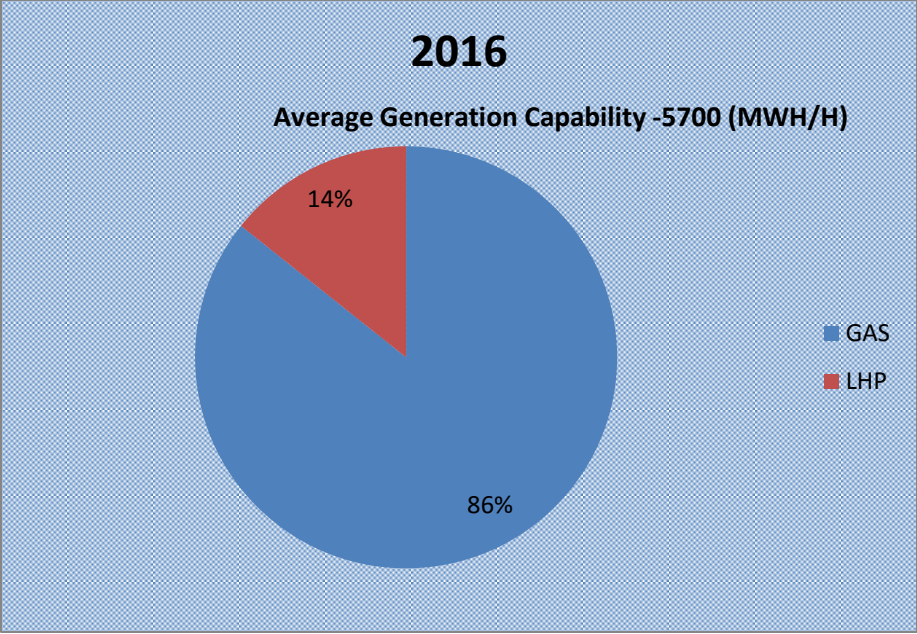


Fig. 1: Current Energy Mix (MW) - Generation

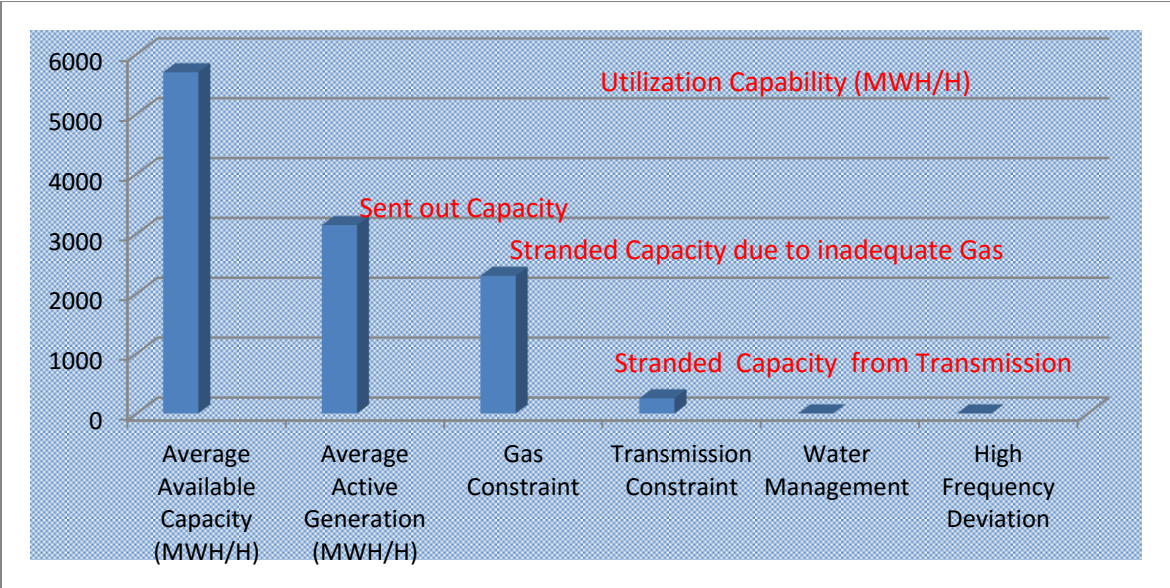


Fig. 2: Average Utilization Capability

**2.2 Energy Mix Target.**

To make electricity supply less vulnerable to disruptions, more affordable, available and reliable Federal Government of Nigeria has set targets for the country`s energy mix to exploit Nigeria potential for coal, solar, wind, biomass, large and small hydroelectric power generation.

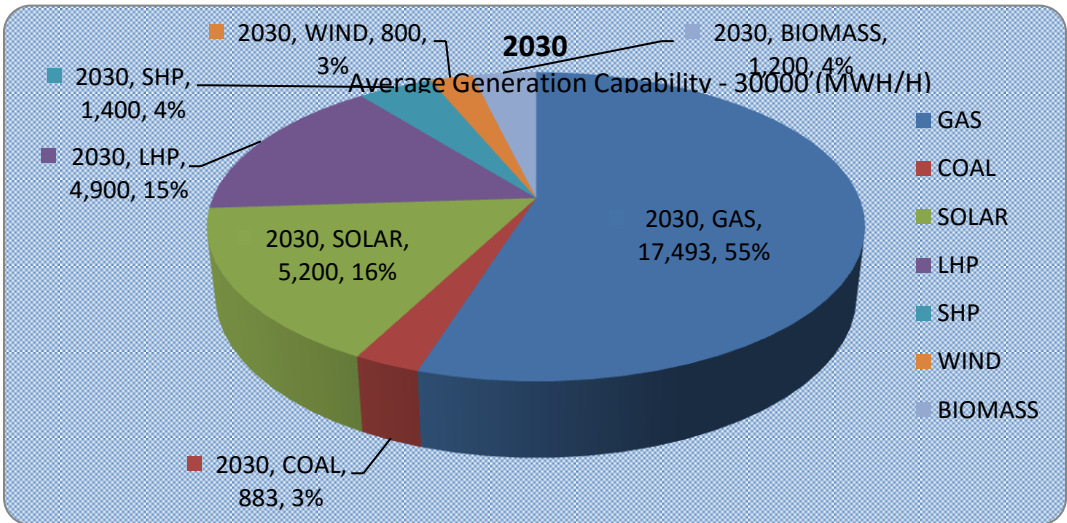
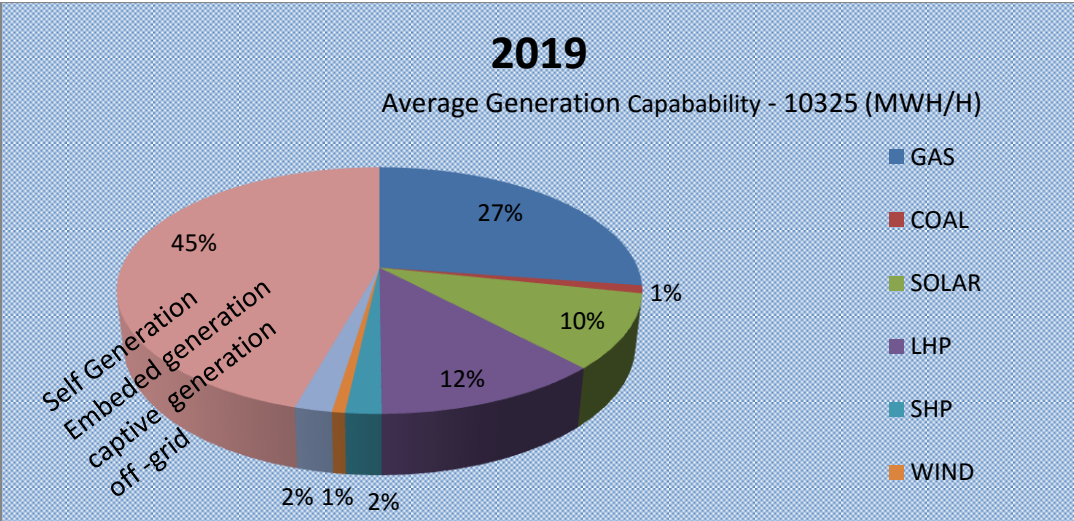
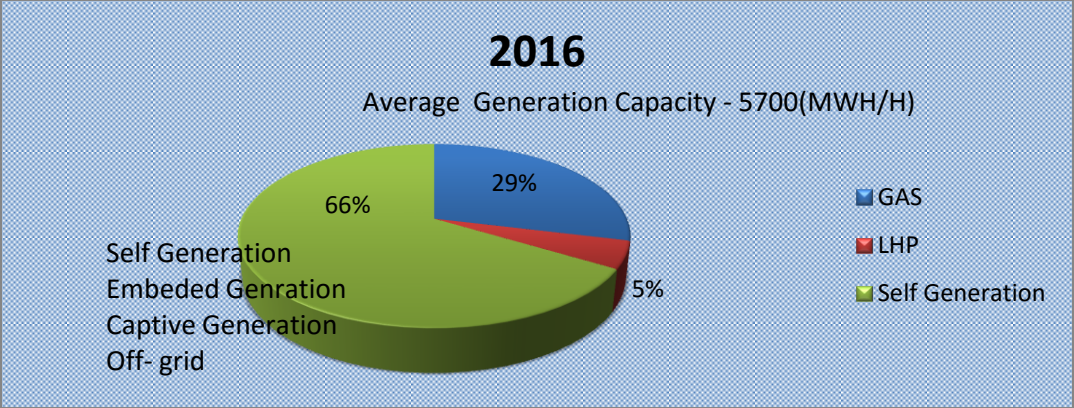


Fig 3: Target Energy Mix

The growth in energy mix would depend on the completion of various hydroelectric power projects funded by the Federal Government of Nigeria and those that are coming under the

Private-Public – Partnership arrangement. The large proportion of the energy mix growth would come through other generation arising from already signed number of Power Purchase Agreements (PPAs) with Bulk Trader as well as those coming through new competitive procurement bid by electricity producers to meet expected target.

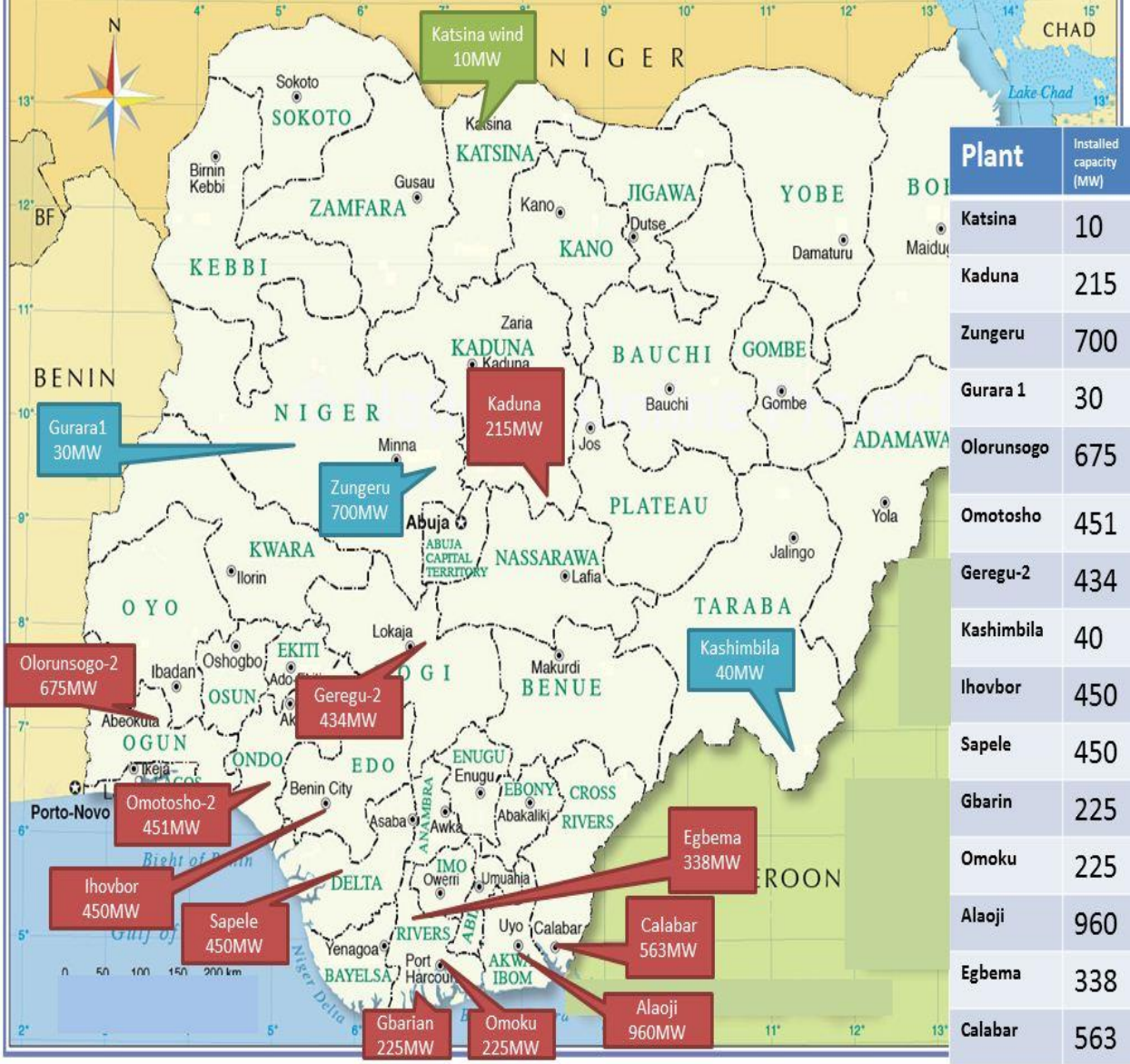


Fig 4: Newly completed/On-going Power Plants for Increased Generation

**2.3 Current Transmission Status**

The transmission sub-sector comprises of 6,680 km of 330kV lines with substation capacity of 10,238 MVA and 9,161 km of 132 kV lines with substations capacity of 11,721 MVA. The total transmission wheeling capacity is 5,300MW as against 6,600MW capacity that is presently required.



NIGERIAN MAP SHOWING THE EXISTING 330kV & 132kV LINES AS AT MAY 2015

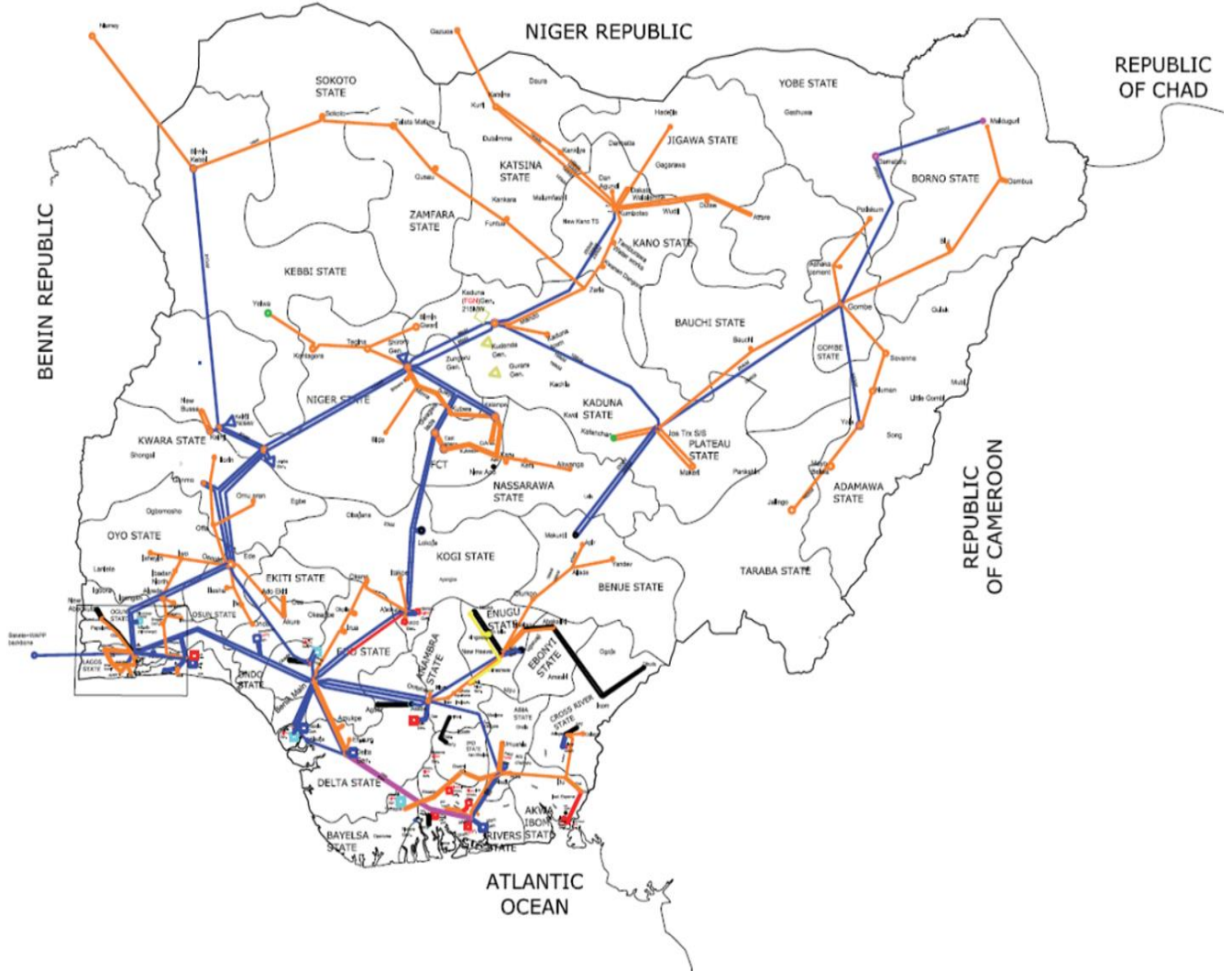


Fig 5: Map of existing transmission lines

6,680 km of 330 kV lines

9,161 km of 132 kV lines

38 no. 330 kV substations

126 no. 132 kV substations

330/132 kV transformer capacity: 10,238 MVA

132/33 kV transformer capacity: 11,721 MVA

Wheeling Capability: 5,300 MW

## 2.4 Transmission Expansion Plan

The Transmission Company of Nigeria has developed a 5-year transmission system expansion plan that covers the period of 2016-2022 and this plan is meant to bring the wheeling capacity of 5,300MW to 20,000MW by 2022 at first instance as part of short term measure and to urgently address the shortfall in transmission sub-sector of electricity supply industry (ESI).

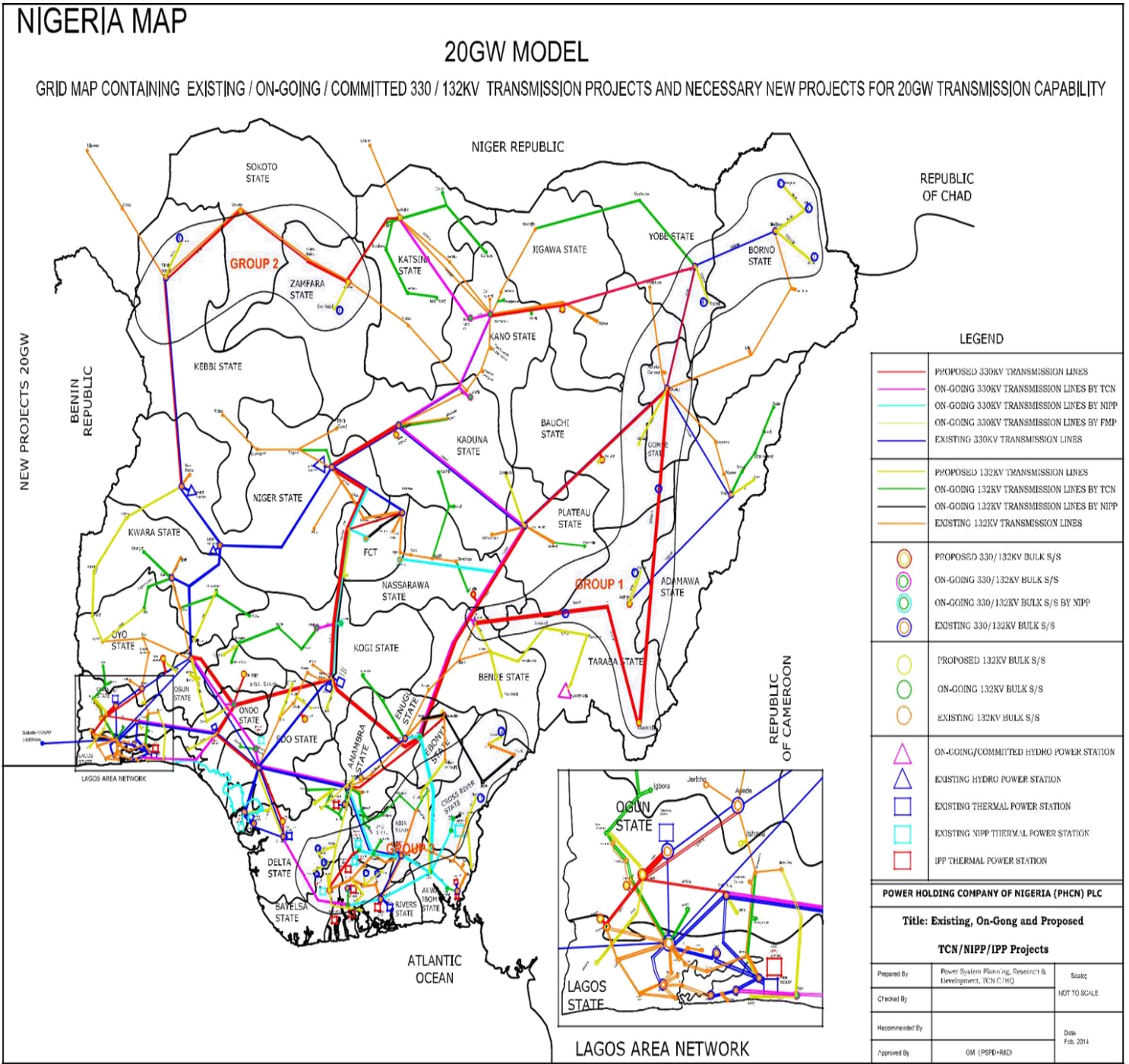


Fig 6: Map of projected Transmission plan

## **CHAPTER III**

### **3.0 INVESTMENT OPPORTUNITIES**

Investment in Nigeria power sector is very attractive due to the growth opportunities in the Nigerian electricity market where demand far outstrips current supply. The potential for strong economic growth is high with population advantage of over 193.4 million. This chapter enumerates in details the investment opportunities, the guidelines, requirements and relevant agencies responsible for issuance of licenses and permits.

#### **3.1 Investment Opportunities in Generation**

##### **3.1.1 Gas**

- Gas Gathering opportunity for Domestic and export use: Current estimates show that about 187Tscft of associated and non- associated gas reserve exist in the country, making Nigeria the 9<sup>th</sup> largest gas reserve holder in the world with Associated gas making up about 88.8Tscft or 49.2%, while Non – Associated gas make up of 91,7Tscft or 50.8% of gas reserve in Nigeria. Nigeria gas production is about 8.5bscft/day. (41%) of this is exported, 2.3bscft/day (28%) is used domestically for power and industries, 1.2bscft/day (15%) is used upstream for gas re-injection, while the balance 0.8bscft (10%) is flared.
- Gas Transportation: Presently there is grossly inadequate pipeline infrastructure, most especially to the newly developed power plants and upcoming IPPs as well as industries. Several thousands of kilometres of pipelines would be needed to meet present gas use. This includes:
  - a. Over 5,000km of new gas pipelines to be laid
  - b. About 5000km of existing lines to be replaced
- Provision of surveillance of pipeline against vandalism: Real time system monitoring of pipeline, detecting, locating and quantifying pipeline leakages.

##### **3.1.2 Gas Fired-Power Plant**

Currently, the Nigerian gas-to-electricity has over 1,000km of pipelines supplying about 600mmsf/day to power stations, while the gas requirement is about 2,699mmscf/day and pipeline of about 5000km for existing power stations, this shows a wide shortfall of gas to generate electricity. Based on the



above gas power expansion plan to year 2020 is part of overall energy mix to increase generation from current 5,000MW gas thermal plants to above 15,000MW of gas fired plant

# GAS WELL LOCATIONS AND TRANSPORTATION INFRASTRUCTURE

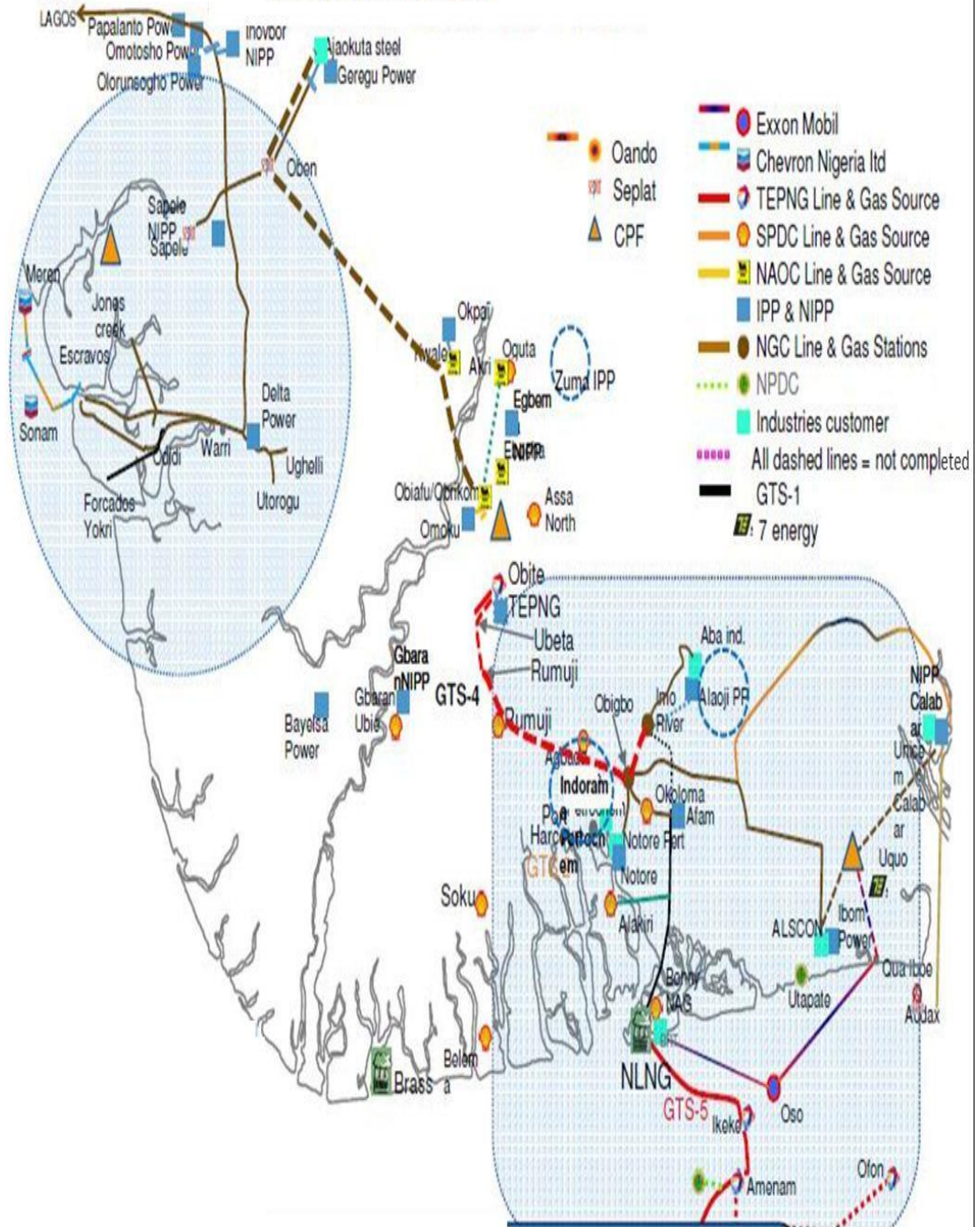


Fig. 1: Map of showing Gas locations, existing and planned pipeline infrastructure

Table 1: Gas requirement for existing power stations

<b>GAS REQUIREMENT FOR EXISTING POWER STATION</b>					
<b>S/N</b>		<b>STATIONS</b>	<b>INSTALLED CAPACITY (MW)</b>	<b>NO. OF UNITS</b>	<b>GAS REQUIREMENT (MMSCF)</b>
1	<b>PRIVATISED PHCN COMPANIES</b>	EGBIN	1,320	6	352
2		SAPELE	720	10	192
3		DELTA	765	18	204
4		AFAM IV-V	300	8	80
5		GEREGU GAS	435	3	116
6		OMOTOSHO GAS	337	8	90
7		OLORUNSOGO GAS	336	8	90
8	<b>NIPP</b>	GEREGU NIPP	435	3	116
9		SAPELE NIPP	500	4	133
10		ALAOJI NIPP	504	5	134
11		OLORUNSOGO NIPP	750	6	200
12		OMOTOSHO NIPP	500	4	133
13		ODUKPANI NIPP	625	5	167
14		IHOVBOR NIPP	450	4	120
15	<b>IPP</b>	OKPAI	480	3	128
16		AFAM VI	695	4	185
17		IBOM	198	3	53
18		A.E.S	224	9	60
19		ASCO	110	2	29
20		OMOKU	150	6	40
21		TRANS AMADI	136	4	36
22		RIVERS IPP	150	6	40
		<b>TOTAL</b>	<b>10,120</b>	<b>129</b>	<b>2,698</b>
<b>3.75MW IS EQUIVALENT TO 1MMSCF</b>					

### 3.1.3 Gas investment requirement

Apart from General requirements, the investment in gas fired power plant or gas processing require the following statutory documents namely:

- Gas aggregate Supply Agreement (GSA) with, Nigerian National Petroleum Company (NNPC), IOCs and Gas Aggregation Company of Nigeria
- Gas Transportation Agreement with Nigeria Gas Company (NGC): Letter from a potential fuel supplier and transporter indicating the inclusion of the fuel needs of the applicant in the supply plans of the fuel supplier and transporter.

## 3.2 Investment in hydropower generation

According to Energy Commission of Nigeria (ECN) and Transmission Company of Nigeria (TCN), the hydro power potential of Nigeria stands at about 14,000MW. This comprises of large, medium and small scheme hydropower across the length and breadth of the country.

### 3.2.1 Investment in Large Hydropower

Feasibility studies on Hydro power in Nigeria have shown the massive investment potential dormant within the nation's rivers and estuaries site as itemized in the table below.

Table 2: Identified Large Hydropower Potential Sites in Nigeria

S/No	Site	River	Technical Feasible Capacities (MW)	Average Annual Energy(GWH)	Category
1	Mambilla	Donga	3600	17,342	Large
2	Lokoja	Niger	1,950	8,540	"
3	Onitsha	Niger	750	3,250	"
4	Markudi	Benue	600	4,750	"
5	Ikom	Cross	400	1,750	"
6	Yola	Benue	350	1,530	"
7	Katsina-Ala	Katsina-Ala	260	1,140	"
8	Beli	Taraba	240	1,050	"

9	Donka	Niger	225	984	"
10	Karamti	Taraba	200	875	"
11	Amper	Amper (Plateau)	200	-	"
12	Afikpo	Cross	180	790	"
13	Atan	Cross	180	790	"
14	Garin Dali	Taraba	135	590	"
15	Gembu	Donga	130	570	"
16	Manyo yin	Taraba	65	284	"
17	Kam	Taraba	60	220	"
18	Suntai	Donga	55	240	"
19	Su	Taraba	45	200	Medium
20	SakinDanko	Suntai	45	200	"
21	Gudi	Mada	40	180	"
22	Kiri	Gongola	40	150	"
23	Richa I	Mosari	35	150	Medium
24	Kombo	Gongola	35	150	"
25	Gwaram	Jama`are	30	130	"
26	Ifon	Osse	30	130	"

*Source: 25 years NEPA power system Dev. Study by OladipoIUmoka and Associate Tractebel Engineering International, Belgium, 1988 and NWRMP Study.*

Note: For Mambilla hydropower scheme: The bankable feasibility study has been completed by Lahmayer International of Germany for Federal Ministry of Power, Works and Housing.

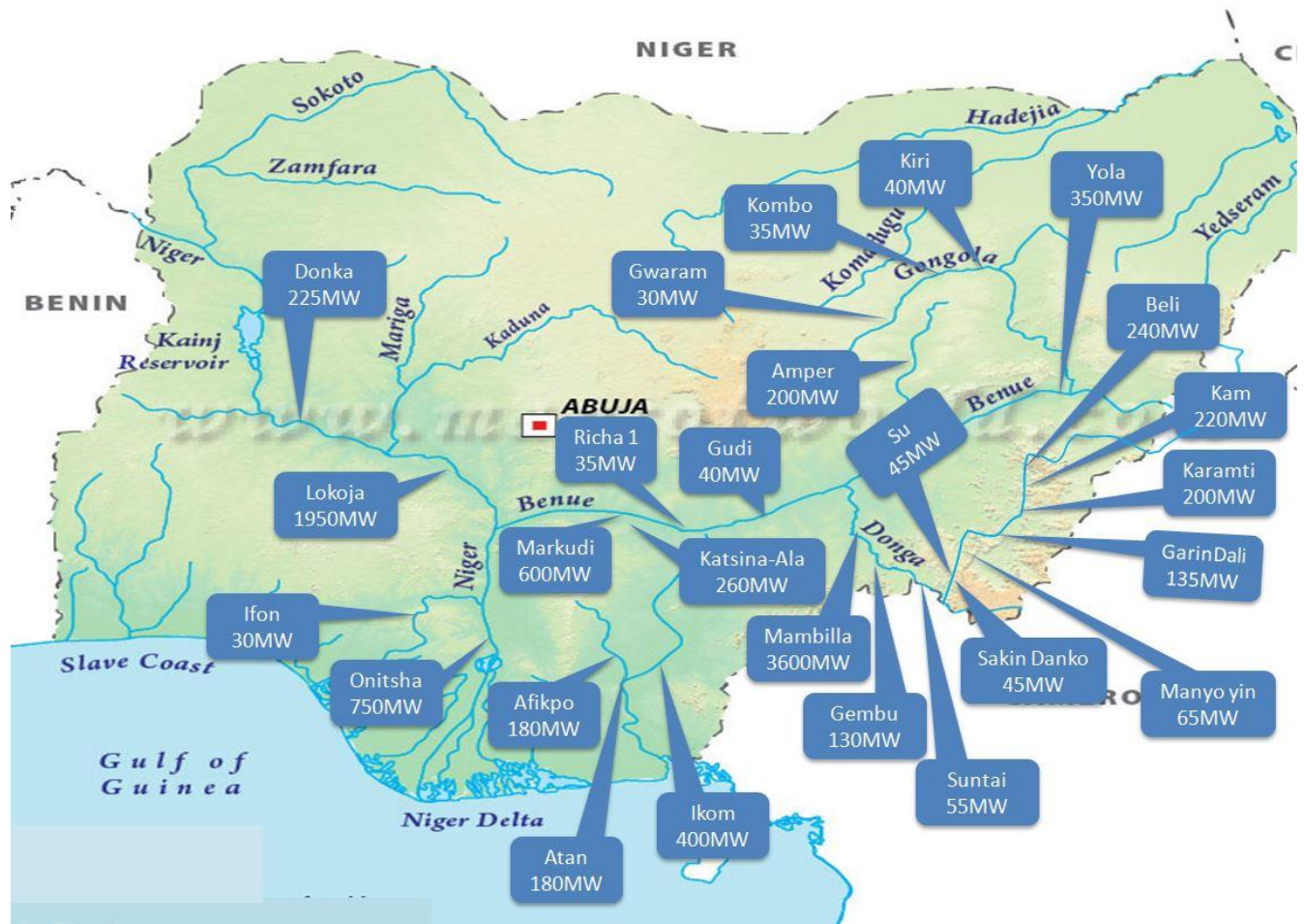


Fig 1: Map showing the Identified Potential Large and Medium hydropower Sites for Investment in Nigeria

### 3.2.2 Investment in Small Hydropower Generation

The fastest way to investing in small hydro in Nigeria lies with converting existing dams to hydro power stations. To this end, there are already over 25 small dams distributed across Nigeria capable of generating about 30MW if converted to hydro power plants. These plants have the capability of feeding into the embedded generation methodology, providing additional power to the distribution companies within their locations.

### 3.2.3 Investment in Eco- System

Another investment opportunity is the ability to create a whole new eco system built on the ability to irrigate agricultural produce. Private investors are to work with the Government in securing viable sites, enabling the legal framework, and most importantly liaising with the State Governments where these stations will be situated to have a cohesive strategy towards water and agricultural management. The scope exists for private investors to cooperate with the Ministry of Power, Works and Housing, the Ministry of Water Resources, the Ministry of Agriculture and the Ministry of



Industry, Trade and Investments and Federal Ministry of Environment. Such coordination can lead to a holistic framework that provides power for processing agriculture while creating paying customers that generate the revenue stream that makes the investment more remunerative.

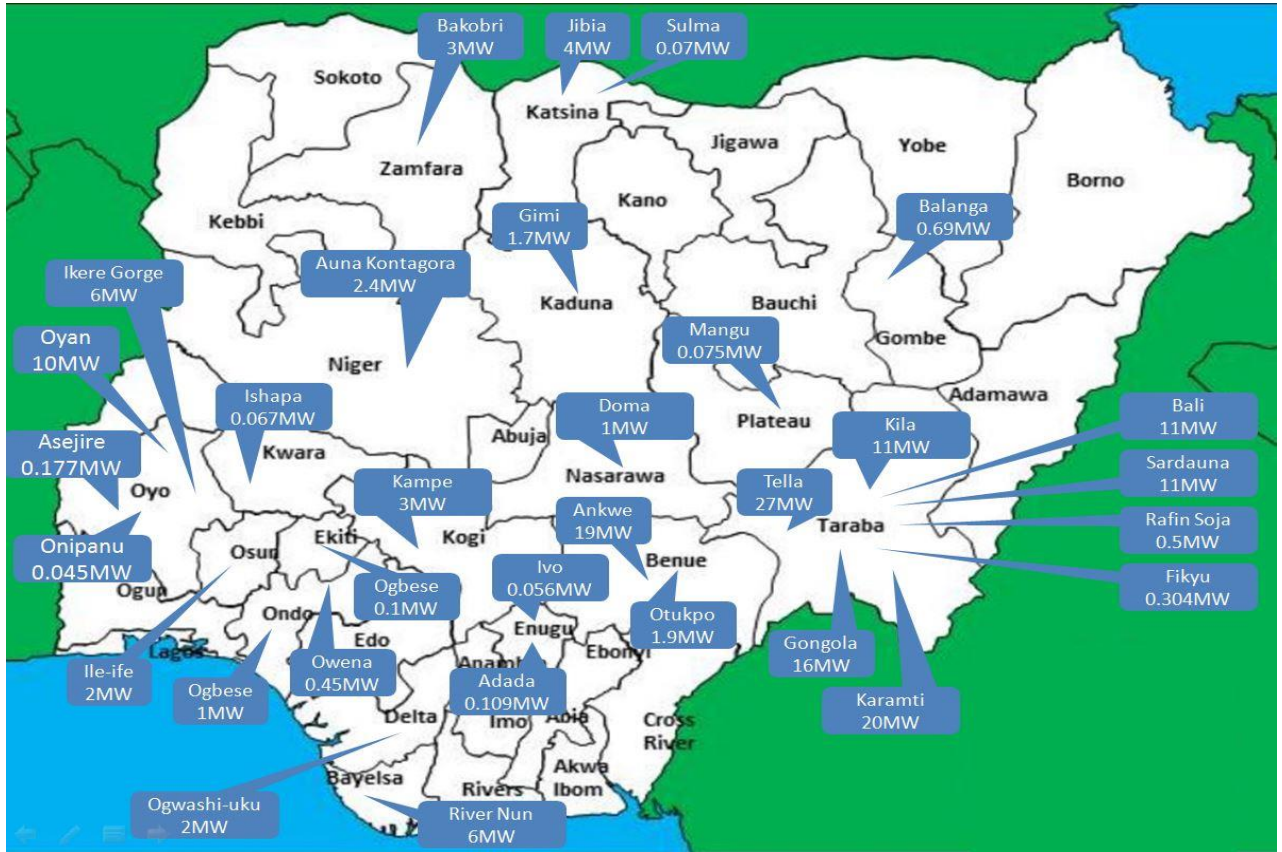


Fig 2: Map showing location of small hydropower potential across Nigeria.

Table 3: Identified Small Hydropower Potential Sites with Population around location

S/N	DAM	CAPACITY(MW)	STATE	POPULATION
1	Oyan	10	Oyo	7,840,864
2	Ikere Gorge	6	Oyo	7,840,864
3	Bakobri	3	Zamfara	4,515,427
4	Kampe	3	Kogi	4,473,490
5	Owena	0.45	Ondo	4,671,695
6	Doma	1	Nassarawa	2,523,395
7	Jibia	4	Kastina	7,831,319

8	Gimi	1.7	Kaduna	8,252,366
9	Ile-Ife	2	Osun	4,705,589
10	Ogbese	1	Ondo	4,671,695
11	Ogwashi-uku	2	Delta	5,663,362
12	AunaKontagora	2.4	Niger	5,556,247
13	Kila	11	Taraba	3,066,834
14	Karamti	20	Taraba	3,066,834
15	Bali	11	Taraba	3,066,834
16	Sardauna	11	Taraba	3,066,834
17	Tella	27	Taraba	3,066,834
18	Ankwe	19	Benue	5,741,815
19	Gongola	16	Taraba	3,066,834
20	Rafin Soja	0.5	Taraba	3,066,834
21	Sulma	0.07	Kastina	7,831,319
22	Balanga	0.69	Gombe	3,256,962
23	Ishapa	0.067	Kwara	3,192,893
24	Onipanu	0.045	Oyo	7,840,864
25	Mangu	0.075	Plateau	4,200,442
26	Ogbese	0.1	Ekiti	3,270,798
27	Adada	0.109	Enugu	4,411,119
28	Ivo	0.056	Enugu	4,411,119
29	River Nun	6	Bayelsa	2,277,961
30	Otukpo	1.9	Benue	5,741,815
31	Asejire	0.177	Oyo	7,840,864
32	Fikyu	0.304	Taraba	3,066,834

**Table 4: Technical Parameters of Some Identified Small hydropower Sites.**



S/N	PROJECT/ LOCATION	TECHNICAL PARAMETERS												
		DAM						POWER PLANT					POWER EVACUATION PLAN	
		PRIMARY PURPOSE	RESERVOIR CAPACITY	MAX. HPP WATER DEMAND (MCM)	DESIGN FLOW (m3/sec)	HEAD	DAM STATUS	TURBINE TYPE/NO.	GENERATOR VOLTAGE (kV)	PLANT OPERATION (ADD) (hrs)	POWER	ENERGY	OFF GRID	ON GRID
(MCM)	(min - max) (m)		(kW)			(kWh)								
1	Rafin Soja Dam Taraba State	Irrigation	0.3	Pumped Storage	2	20	Under Construction	Ossberger Crossflow /2	0.415	NP	500	1,600,000		Yes
2	Sulma Dam Katsina State	Irrigation, Water Supply	4.3	N/P	1.003	10	Under Construction	Kaplan Horiz. Turbines /2	0.4	24	70.22	251,579	Yes	
3	Balanga Dam	Irrigation, Water Supply	72.6	N/P	5	19.7	Completed	Francis (No. 2)	0.4	24	690	4,539,000	N/P	N/P
4	Girri Earth Dam Kaduna State	Irrigation	54.52	N/P	4.1	13	Existing	Kaplan /5	0.415	24	1,672	12,096,132	Yes	
5	Ishapa Dam Kwara State	Water Supply	2.5	1.4	1.1	8	Completed	Francis (No. 1)	11	NP	67	44.6	N/P	N/P
6	Onipanu Dam Oyo State	Water Supply	1.5	N/P	0.75	5	Completed	Francis (No. 1)	11	NP	45	29	N/P	N/P
7	Mangu Dam Plateau State	Irrigation, Water Supply, Flood Control, Fishing	9.1	4.1	1.2	7.6	Under Construction	Crossflow /2	0.415	NP	70	5,518,800	Yes	
8	Ogbese Dam Ekiti State	Water Supply	307	223.8	10	6.6	Under Construction	Kaplan Horizontal /3	0.4	NP	1000	N/P	Yes	
9	Ogwashe Uku Delta State	Water Supply	469.25	394.1	14.38	11.5	Under Construction	4	11	21	2000	9,198,000	Yes	
10	Adada Dam Enugu State	Water Supply, Irrigation	3	N/P	1.45	14	Under Construction	Kaplan/2	N/P	NP	109	954,840	Yes	
11	Ivo Dam Enugu State	Water Supply, Irrigation	3	N/P	1.7	6	Under Construction	Kaplan/2	N/P	NP	56	490,560	Yes	
12	Auna Kontagora Dam, Niger State	Irrigation	300	N/P	15.58	18	Under Construction	Kaplan /4	6.3	NP	2,384	21,024,000		Yes
13	River Nun (Run-off) Bayelsa State	Power Generation	No Dam (Run-off River)	7.98	23.26	10	No Dam	Kaplan	11	NP	6,000	175,250,000		Yes
14	Otukpo Dam Benue State	Water Supply, Irrigation	132.4	N/P	20	13.74	Under Construction	Kaplan/3	6.3	NP	1,900	4,940,000		Yes
15	Asejire Dam Oyo State	Domestic Consumption	32.58	N/P	1.55	13	Completed	Horizontal Francis/No. 1	11	NP	177	630,000		Yes
16	Fikyu Dam Taraba State	Irrigation, Water Supply	48.9	N/P	4.9	18	Under Construction	Kaplan /2	11	24	304.5	1,025,576	Yes	
17	Ile-Ife Dam Osun State	Water Supply	28.7	N/P	13.06	20	Under Construction	Kaplan/2	11	NP	2000	60,000,000		Yes

### 3.2.4 Investment Guideline and Requirements for Hydropower Generation

After meeting up the general requirements, the following steps are required:

- All water ways belong to the Federal Government of Nigeria and Federal Ministry of Water Resources (FMWR) is the custodian.
- FMWR is vested with the responsibility of issuing Water Rights to investors for Hydropower generation, fisheries etc.
- Investors interested in Small and Medium Hydro power projects after completing their Feasibility Studies, are expected to apply for water usagerights from the National Integrated Water Resources Management Commission (NIWRMC);
- Investors interested in Large Hydro require Water Concession Agreement for water right

### 3.3 Investment in Coal – Fired Power Generation

Nigeria is endowed with an estimated Coal reserve of over two billion metric tons. 12.8 million tons of sub-bituminous coal that can power 10,000 MW power plant for 30 years. There are existing coal mines in the country, most of which are under concession by the Federal Government. The Ministry of Solid Minerals has covered 100 Cadastral Units each for the identified Ashokpa – Odolu coal block in Idah Local Government Area of Kogi State and Kumuyel- Futuk Coal block in Gombe States/Bauchi State for the proposed Coal to Power project investments, . However, detailed exploration is needed to be executed on both locations/deposits. Interested investors are to liaise with Federal Ministry of Solid Minerals Development for further details of project implementation. The table below shows the locations of the coal mines with the type of coal and the estimated amount of deposits which are suitable locations for coal power plants. Apart from investment on coal fired power plant, production of bio- fuel and ethanol is another good investment opportunities.

Table 4: Potential Coal Block

S/N	MINE LOCATION	STATE	TYPE OF COAL	PROV EN RESERVE (MT)	BORE-HOLE RECORDS	COAL OUTCROP SEAM THICKNESS (M)	DEPTH OF COAL (M)
1	Okpara Mine	Enugu	Sub-bituminous	24	20	Many(1.5M)	180
2	Onyeama Mine	Enugu	Sub-bituminous	22.4	20	Many (1.5M)	140
3	Ihioma	Imo	Lignite	N.A	Nil	Many	20-80
4	Ogboyaga	Kogi	Sub-bituminous	107	31	17(0.8-2.3m)	20-100

5	Ogwashi-sabaObamkpa		Lignite	63	7	4(3.5M)	15-100
6	Ezimo	Enugu	Sub-bituminous	56	4	(1.3m)	80
7	Inyi	Enugu	Sub-bituminous	20	4	(0.9-2.0)m	25-27
8	Lafia/Obi	Nassarawa	Bituminous (Cokable)	21.42	123	(1.3m)	80
9	Obi/Nnewi	Anambra	Lignite	N.A	3	N.A	20-100
10	Afikpo/Okigwe	Ebonyi/Imo	Sub-bituminous	N.A	Nil	N.A	20-100
11	Amansiodo	Enugu	Bituminous	N.A	3	N.A	563
12	Okaba	Kogi	Sub-bituminous	73	Many	(0.8-2.3m)	20-100
13	Owukpa	Benue	Sub-bituminous	57	Many	(0.8-2.3m)	20-100
14	Maiganga	Gombe	Sub-bituminous	>50	Many	0.1-6.1m	10-60
15	Doho/Molko	Gombe	Lignite/Sub-bituminous	NA	7	0.1-1.3m	20-30
16	Omelewu (Imane)	Kogi	Sub-bituminous	25	25	0.1-5.2m	4-60
19	Lamza-Chikila	Adamawa	Sub-bituminous	NA	NA	Nil	NA
18	KurumuPindiga	Gombe	Sub-bituminous	NA	NA	Nil	NA
19	GindiAkwati	Plateau	Sub-bituminous	NA	NA	Nil	NA
20	Janata Koji	Kwara	Sub-bituminous	NA	NA	Nil	NA
21	Enugu Ezike	Enugu	Sub-bituminous	NA	NA	NA	NA
22	Akpanya-Ogboligbo (Igalamela LGA)	Kogi	Sub-bituminous	NA	NA	NA	NA
23	Akunza-Duduguru Coal	Nasarawa	Sub-bituminous	NA	NA	NA	NA
24	Akpuneje/Onyage de coal	Benue	Sub-bituminous	NA	NA	NA	NA
25	Janata Koji	Kwara	Sub-bituminous	N.A	N.A	Nil	N.A
26	Ashokpa-Odolu	Kogi	Sub-bituminous	N.A	N.A	N.A	N.A

27	Ebeje-Irabor	Kogi	Sub-bituminous	N.A	N.A	N.A	N.A
28	Akpacha-Ajadoma Co	Kogi	Sub-bituminous	N.A	N.A	N.A	N.A
29	Ikpo-Abacha	Kogi	Sub-bituminous	N.A	N.A	N.A	N.A

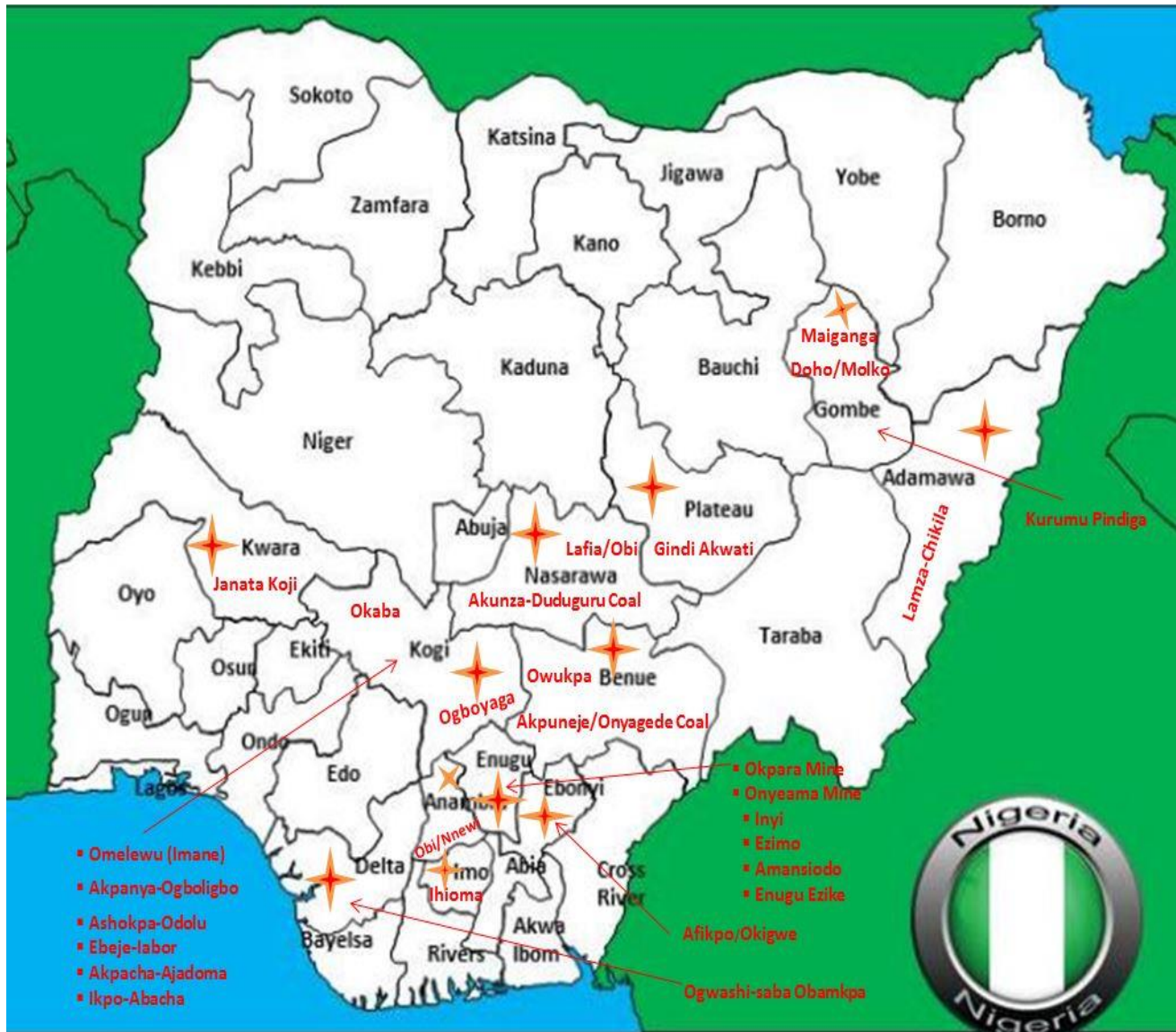


Fig. 3: Map showing various coal blocks across Nigeria

### 3.3.1 Investment Guideline and Requirements for Coal- Fired Generation

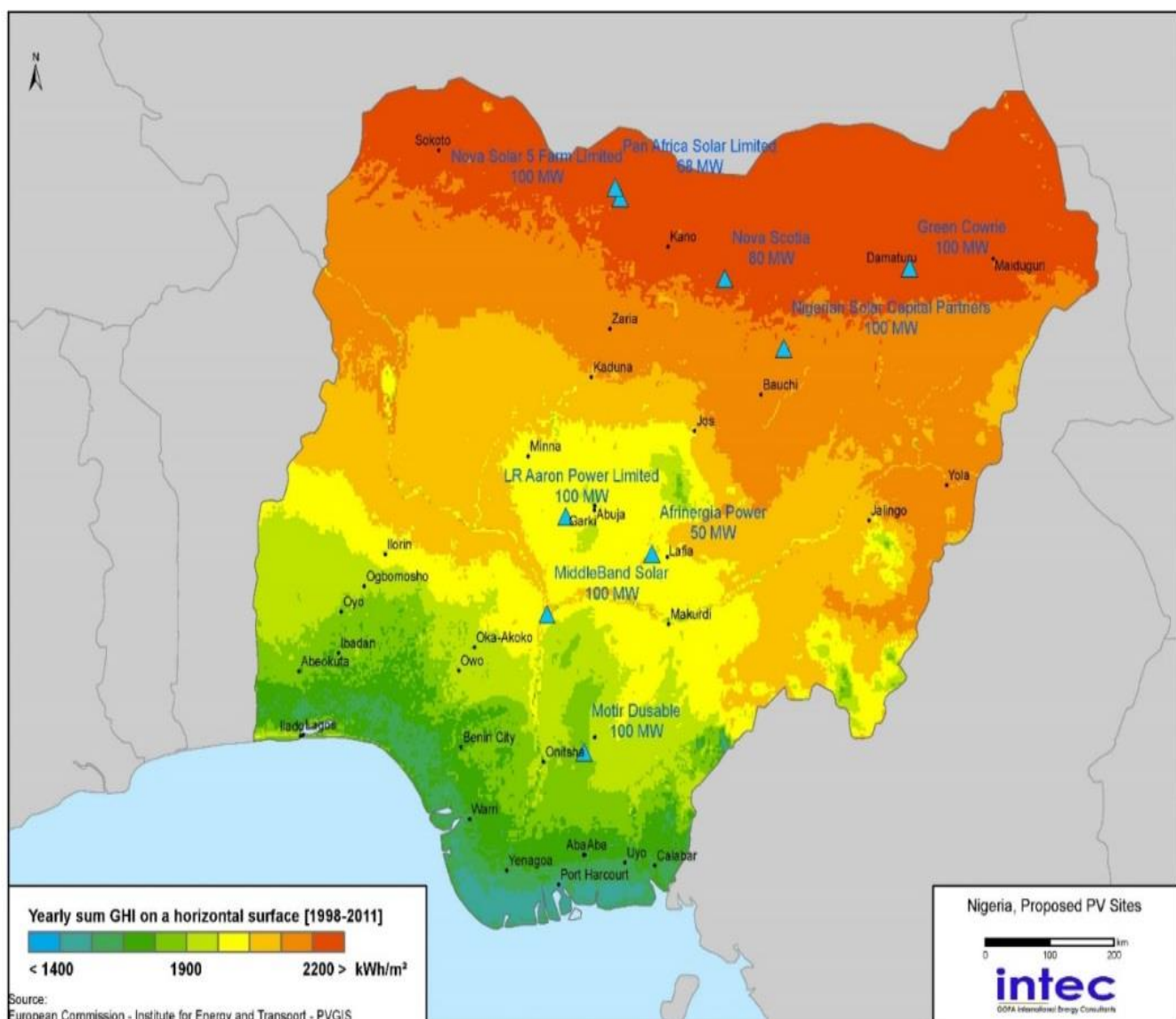
After meeting up the general requirements, the following steps are required for Coal – Fired power generation:

- Coal Blocks Concession Agreement and Transportation Agreement from Federal Ministry of Mines and Steel Development; or With Private owners of Coal Block
- Analysis by a reputable Independent Company of the Coal site intended to be developed; or
- Development of the deposit for commercial exploitation.

### 3.4 Investment opportunities in other Renewable Energy.

#### 3.4.1 Solar

Northern Nigeria has some of the highest solar irradiation in the world. Solar power plants are environmentally friendly as they emit no carbon into the atmosphere. They have a much shorter construction time than conventional plants. The technologies involved in developing a solar plant



have been evolving rapidly reducing the cost over a short period of time.

Fig .4: Nigeria's Solar Global Horizontal Irradiance and Potential Power Generation Projects

Quite a number of feasibility studies that have been done on the solar space in recent years and they are available for investors' perusal. Fig. 4 showcases some of the proposed location for solar PV power plants. As shown, the best yields are in the northern part of the country where the irradiation exceeds 2200KWh/m<sup>2</sup>, the southern part of the country also have good yields at some certain area.

Investments in the solar space would mainly focus on building power plants and feasibility studies on areas with good yields. The procurement of solar power is moving to the competitive stages whereby the capacity is competitively procured. This would enable more players to participate and ultimately make it more popular in Nigeria by driving down the cost.

### **Preliminary Designs for Identified Solar Projects**

(a) Preliminary Design Report for Solar project in Taraba State

(b) Preliminary Design Report for Solar project in Bida- Niger State

### **3.4.2 Wind**

Nigeria has good wind resources in certain states that stretch from the middle belt to the Northern plains. Currently, there is a 10MW wind power plant under development in Katsina which is near completion and will be commissioned soon. NBET is in negotiations with JBS Wind power for the construction of a 100MW Wind-power farm in Plateau State.



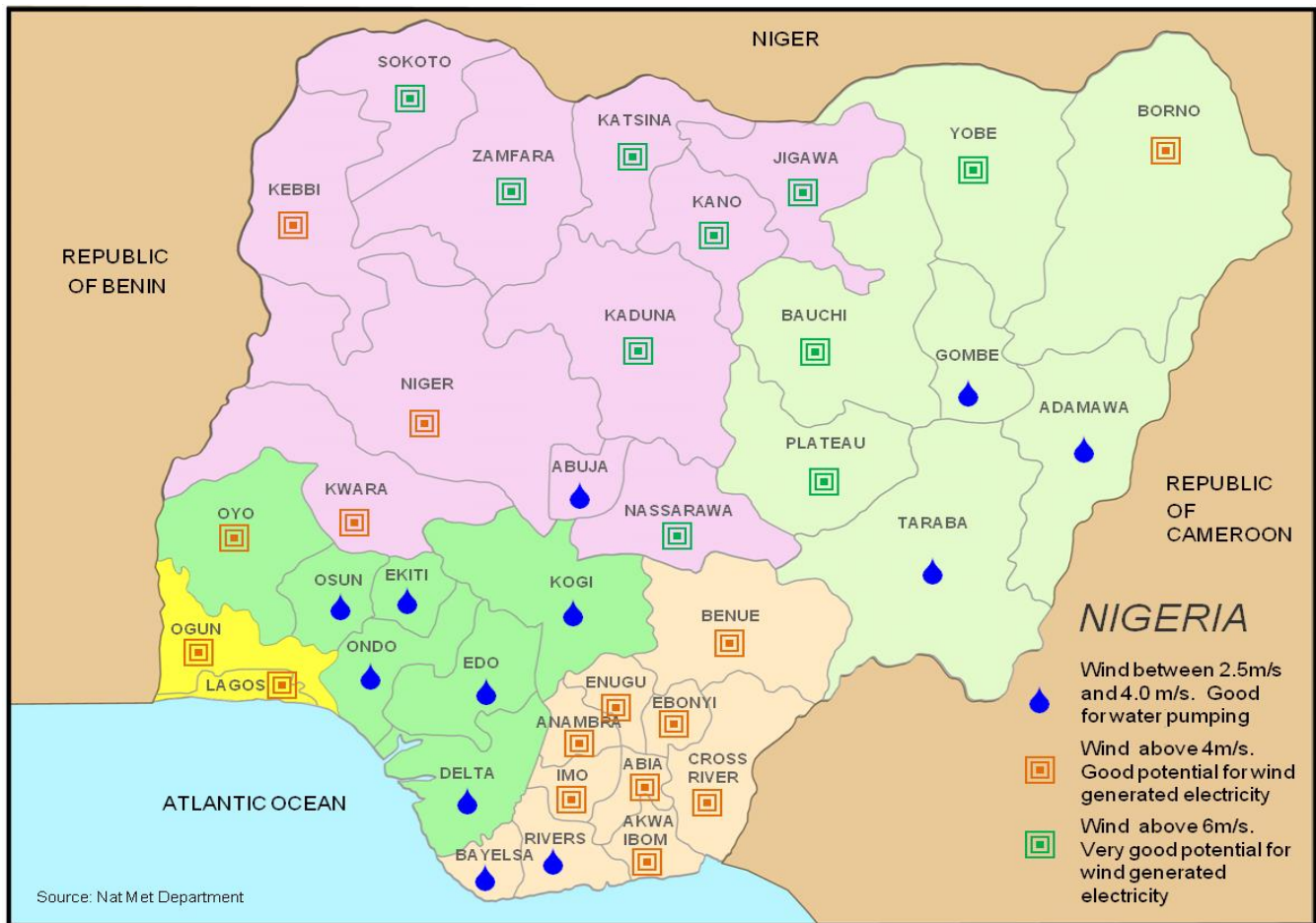


Fig. 5: Map of Wind Potential Distribution in Nigeria

Wind power has little or no emissions; it does not require fuel to power its turbines. It has a shorter construction time when compared to other technologies of power generation and it also has very low maintenance cost. The northern states in Nigeria have best potentials for wind generation. Investors can key into the high wind potentials indicated in Fig. 5 and vast land area in the northern part to set up wind power plants.

### 3.4.3 Biomass

Nigeria has a population of 193.4million people and generates waste on a daily basis. Biomass power plants are especially useful for waste that is not bio-degradable which make up most of the waste in landfills. It serves areas with high population density that generates the most waste by transforming the waste generated into energy used to power homes and businesses. Fig 5, pg.5 shows the population density and clusters in Nigeria. As shown above, Lagos State is obviously the most populated with over 15 million residents which in turn generates the most waste. These wastes can ultimately be harnessed into electricity through a biomass power plant. Other states with adequate population to generate waste for biomass power are Anambra, Kano, Imo, Enugu, Osun and Ekiti States.

**3.4.4 Investment Guideline and Requirements for solar, Wind and Biomass Generation**

After meeting up the general requirements, the following steps are required for Solar and Wind:

- Investors interested in either Solar or Wind Power projects require Energy Yield Report with on-site measurement by a reputable Independent Company (Micro sizing);
- Proof of minimum of six (6) months on – site measurement for Solar and wind
- Proof of Waste Supply Agreement and transportation agreement for Biomass generation.

**3.5 INVESTMENT OPPORTUNITY IN TRANSMISSION AND DISTRIBUTION**

The national grid, which comprises of 330 kV and 132 kV networks currently, has a wheeling capability of 5,300 MW under constrained loading conditions. The network lacks adequate redundancy, which creates instability and frequent outages. Due to the paucity of fund through the Federal Government Budgetary funding, the sector is seeking for different models of financing through contractor finance of new transmission projects, Rehabilitate Operate and Transfer (ROT) and Management Contract. The expected Grid development plan is shown in table below.

Table 5: Expansion plan

<b>Year</b>	<b>Expected Grid Capacity MW</b>
2016	6,600
2018	10,000
2020	13,000
2021	16,000
2022	20,000



Investments are expected on refurbishing existing facilities, restoring the network to its original capacity, completing on-going projects in various stages of construction, initiating the construction of over 120 newlines and substations, and many new voltage control facilities and expand the network.

### **3.5.1 INVESTMENT OPPORTUNITIES IN MANUFACTURING OF POWER EQUIPMENT**

- Repair and Maintenance Transformer workshops
- Meter manufacturing
- Manufacturing of electrical cables
- Manufacturing of solar panels
- Billing systems
- Automation of electrical procedures
- Fraud detection and reduction of commercial loss

## APPENDIX I

### RELEVANT AGENCIES IN THE POWER SECTOR

S/N	AGENCIES	ROLE	CONTACTS
1.	Federal Ministry of Power, Works & Housing	Policy formulation and monitoring	Headquarter Mabuchi, Abuja, FCT, <a href="http://www.power.gov.ng">www.power.gov.ng</a>
2.	Nigerian Electricity Regulatory Commission (NERC)	Issuance of licenses to operators in the Sector and regulation of their activities	Adamawa Plaza, Plot 1099, First Avenue, Off Shehu Shagari Way, Central Business District, Abuja Tel: +234-09-462-1400, 09-462-1401. <a href="mailto:info@nercng.org">info@nercng.org</a>
3.	Transmission Company of Nigeria (TCN)	Management of the National Grid	Plot 441, Zambezi Crescent Abuja Website: <a href="http://www.tcnorg.com">www.tcnorg.com</a>
4.	Nigeria Bulk Electricity Trading (NBET) Plc	Formulation and Execution of Power Purchase Agreements (PPAs)	8th Floor, Bank of Industry Building, Off Herbert Macaulay Way, Central Business District, FCT, Abuja. <b>Telephone:</b> +23494605630, +23494605630 <b>Email:</b> <a href="mailto:info@nbet.com.ng">info@nbet.com.ng</a> ; <a href="http://www.nbet.com.ng">www.nbet.com.ng</a>
5.	Gas Aggregation Company Nigeria Limited (GACN)	Allocation of Gas for domestic use	1 B Malcolm Fraser Street, Asokoro, Abuja: E-mail: <a href="mailto:info@gacn.com">info@gacn.com</a> Website: <a href="http://www.gacn.com">www.gacn.com</a>
6.	Nigeria Gas Company (NGC)	Management of Gas infrastructure and Gas transportation	NNPC Towers, Central Business District, Herbert Macaulay Way, P.M.B. 190, Garki, Abuja. <a href="mailto:webmaster@nnpcgroup.com">webmaster@nnpcgroup.com</a>
7.	Rural Electrification Agency (REA)	Management of remote and off – grid Power projects	No. 22 Freetown Street, Wuse II, Abuja FCT, Email: <a href="mailto:info@rea.gov.ng">info@rea.gov.ng</a> Website: <a href="http://www.rea.gov.ng">www.rea.gov.ng</a>
8.	Nigerian Electricity Management Services Agency (NEMSA)	Ensuring quality services and safety	Corporate Headquarters 4 Dar Es Salaam Street, off Aminu Kano Crescent, Wuse 2, Abuja, FCT Tel: 07010000102, 08036745149

			<a href="mailto:info@nems.com.ng">info@nems.com.ng</a>
9.	National Power Training Institute of Nigeria (NAPTIN)	Development of human capital	Plot No. 21, Co, Institute and Research Cadastral Zone, Idu Industrial Area, Near Wupa Waste Treatment Plant, Abuja. Tel:+234(0)706 777 7559 Email:info@naptin.org.ng
10.	Nigerian Investment Promotion Commission (NIPC)	Investment Promotion and Monitoring Activities	Plot 1181, Aguiyi Ironsi Street, Abuja, Federal Capital Territory, Nigeria Telephone:+234-9-290-4882, E-mail: osicinfodesk@nipc.gov.ng, infodesk@nipc.gov.ng or nipc@nipc.gov.ng Website: <a href="http://www.nipc.gov.ng">www.nipc.gov.ng</a>
11.	Federal Ministry of Water Resources	Planning, designing supervision of construction and regulating of dams and reservoirs in Nigeria,	P.M.B. 159, Block 'A', Old Secretariat Area I Garki, Abuja Tel: 09-2340206; 2342684; 2342376
12.	Federal Ministry of Environment	Issuance of Environment Impact Assessment	Headquarter, Block C, Mabuchi, FCT, Abuja, Nigeria  +234-09-5233611, +234-09-5233611
13.	Federal Ministry of Solid Minerals Development	Allocation of coal sites	2 Luanda Crescent, Plot 360, Adetokumbo Ademola Crescent Wuse II, Abuja. Email: <a href="mailto:info@mmsd.gov.ng">info@mmsd.gov.ng</a> Website: <a href="http://www.mmsd.gov.ng">www.mmsd.gov.ng</a> OR National Steel Raw Materials Exploration Agency,18 Rahab Road, Malali Village, Kaduna
14.	Infrastructure Concession Regulatory Commission (ICRC)	Infrastructure Concession	Plot 1270 Ayangba Street, Area 11 Garki, Abuja.