



# WIND POTENTIAL AND DEVELOPMENT STRATEGY FOR NIGERIA\*

By

**Professor Eli Jidere Bala**  
**Director General,**  
**Energy Commission of Nigeria, Abuja.**  
**[dg@energy.gov.ng](mailto:dg@energy.gov.ng) or [elijidere@gmail.com](mailto:elijidere@gmail.com)**

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# Outline

- **Introduction**
  - Nigeria and its Socio-Economic Indicators
  - Institutional Framework of the Nigerian Energy Sector
  - Drivers of RE Development in Nigeria
  - Policies/Regulations for RE Development in Nigeria
- **Overview of Nigerian Energy Resource Base**
- **Wind Potential in Nigeria**
- **Wind Policies in Nigeria**
- **Wind Development Strategies in Nigeria**
- **RE Investment Incentives**
- **Challenges**
- **Concluding Remarks**

# 1.

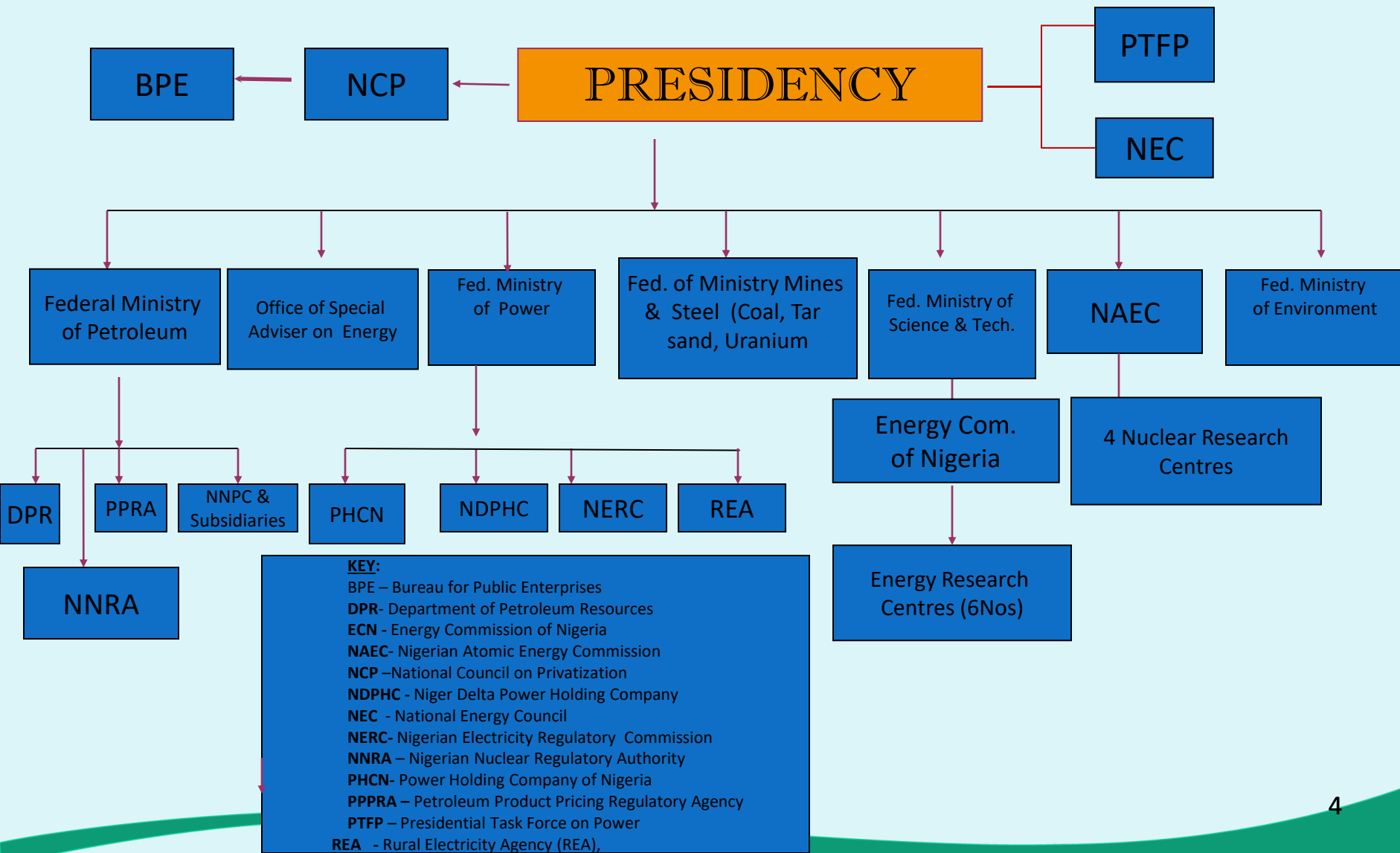
# Introduction



**Location of Nigeria in Africa**

<b>Location</b>	Nigeria situated between latitudes 4° N and 14° N and longitudes 3° E and 14° E
<b>Total Area</b>	92.4 million hectares (Land 86%, Water 14%)
<b>Polity</b>	Democracy (Presidential System)
<b>Population / rate</b>	198 million @ 3.1 % (2017)
<b>Economic Indicators</b>	
<ul style="list-style-type: none"> <li>Nominal GDP</li> <li>Major Contributors to GDP</li> </ul>	₦114.9 trillion = 375.8 Billion USD (2017) - Agriculture: 25.08% - Industries: 22.26% - Service: 52.66%
<ul style="list-style-type: none"> <li>GDP growth rate</li> </ul>	0.8% (2017)
<ul style="list-style-type: none"> <li>Interest rate (MPR)</li> </ul>	13.5%
<ul style="list-style-type: none"> <li>Exchange rate</li> <li>Inflation rate</li> <li>Major contributor to foreign Exchange earnings</li> </ul>	US\$1 = N360.33 15.4% Oil (approx. 97% )

# 1. Introduction: Institutional Framework in the Energy Sector



# Introduction: Drivers of Renewable Energy Investments in Nigeria



- Policy/Political will
- Availability of Renewable Energy Resources
- Imperative for Energy Security
- Climate Change
- Need for Diversification of Economy
- Job Creation Imperative
- Desire for Increased access to energy
- Available Matured Technology
- Availability of domestic global cheap funds

# 2. Energy Resources in Nigeria



## a) Fossil Energy Resources and Nuclear Energy Sources

S/N	Resources	Reserves (2017)	Production (2017)	Domestic Utilization (2017)
1	Crude Oil	36.97* billion barrels	0.661 billion barrels	0.145 billion barrels
2	Natural Gas	199.09 Tscf	2.94 Tscf	88% : Utilized 12% : flared
3	Coal	2.7 billion tonnes	0	Negligible
4	Tar Sands	31 billion barrels of oil equivalent	0	18.25 million barrels
5	Nuclear	Yet to be quantified	0	30kW experimental nuclear reactor

\*Includes condensates (Oil: 31,419.71 billion bls; Condensates: 5552.20 Million bls)

Source: OPEC (2015)

## 2. Energy Resources in Nigeria ... Cont'd



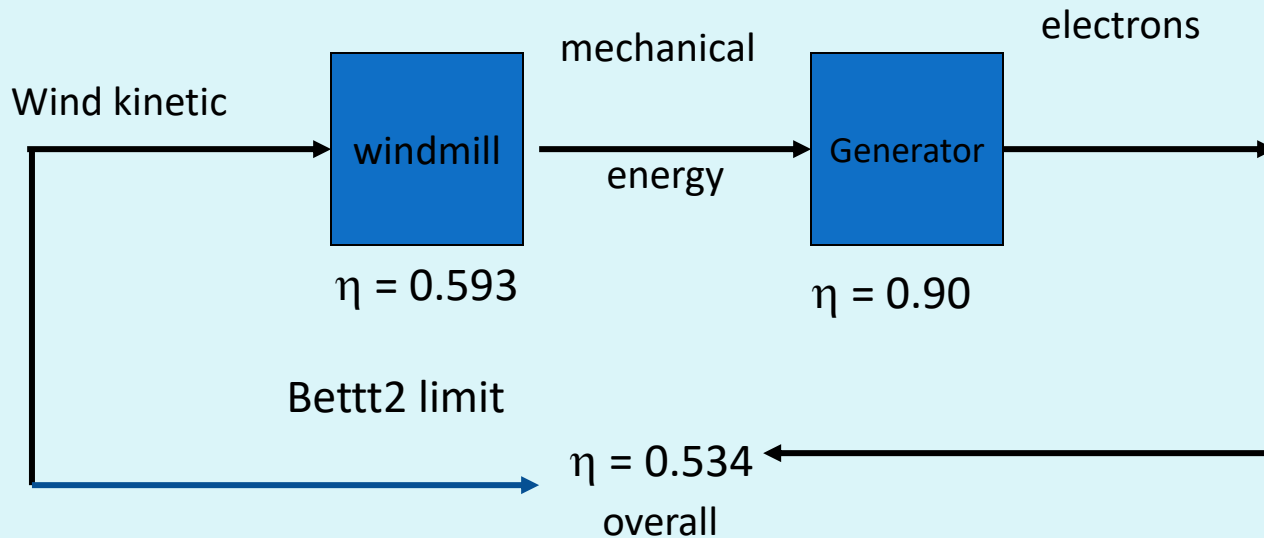
### b) Renewable Energy Resources

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

Source: Renewable Energy Master Plan (REMP)

# 3. Wind Potential in Nigeria

Wind Energy exist in the form of Kinetic energy, therefore, wind potential is determined by the cube power of the wind speed, i.e.  $P = \frac{1}{2} \rho v^3 A$





### 3. Wind Potential in Nigeria .. Contd.

- The Laymeyer's wind resource mapping was carried out on-shore. However, constant speeds that would enable commercially viable power generation may only be obtained offshore.
- Developing an off-shore wind mapping to further investigate the potential of wind power in Nigeria is imperative.
- In Nigeria, there are two larger wind farm projects ongoing, namely 10 MW in Katsina, and 100 MW in Plateau State.

# 3. Wind Potential in Nigeria .. Contd.



Table 2: Mean monthly wind speeds in  $\text{ms}^{-1}$  (at 10m height) derived from 1951-1975 meteorological data

Station	Lat. ( $^{\circ}\text{N}$ )	Long ( $^{\circ}\text{E}$ )	Elevation altitude (m)	Monthly Wind Speeds ( $\text{ms}^{-1}$ )												Mean	S.D
				Jan	Feb	Mar	Apr.	May	Jun	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.		
1 Benin City	6.32	5.6	77.52	1.39	2	2.2	2.0	1.8	1.89	2.1	2.4	2.1	1.78	1.36	1.47	1.873	0.310
2 Calabar	4.97	8.35	63.14	1.45	1.25	1.70	1.53	1.39	1.39	1.53	1.59	1.64	1.50	1.45	1.50	1.493	0.116
3 Enugu	6.47	7.55	141.5	2.81	3.03	3.34	3.37	3.06	2.98	3.12	3.28	2.75	2.50	2.39	2.87	2.958	0.298
4 Ibadan	7.43	3.9	227.23	1.61	2.50	2.95	2.61	2.50	2.39	2.92	3.17	2.45	1.75	1.34	1.39	2.298	0.596
5 Ilorin	8.48	4.58	307.3	1.12	2.16	2.76	2.49	1.99	1.82	2.42	1.82	1.48	1.52	1.18	1.12	1.823	0.536
6 Jos	9.87	8.88	285.58	3.53	3.53	3.95	4.34	4.03	4.34	4.03	4.0	3.48	3.28	3.89	4.25	3.886	0.340
7 Kaduna	10.6	7.45	645.38	4.00	3.04	2.84	3.17	3.27	3.24	3.04	2.81	2.19	2.12	3.17	5.05	3.162	0.740
8 Kano	12.1	8.53	472.14	2.55	2.03	2.70	3.25	3.99	3.89	3.83	2.76	2.63	2.40	3.70	3.28	3.084	0.632
9 Lagos (Ikeja)	6.58	3.33	39.35	2.23	2.40	2.59	2.45	2.35	2.35	2.62	2.86	2.35	1.97	1.88	2.07	2.343	0.268
10 Lokoja	7.78	6.74	61.4	1.35	1.95	2.88	2.59	2.02	1.93	1.77	1.71	1.81	1.73	1.88	1.90	1.960	0.388
11 Maiduguri	11.9	13.1	353.8	3.29	3.37	3.52	3.24	3.34	3.34	3.18	2.48	2.22	2.67	3.14	3.01	3.058	0.379
12 Makurdi	7.73	18.5	112.85	2.38	1.82	2.88	2.88	2.51	2.45	2.19	2.55	2.12	2.55	2.25	1.73	2.359	0.345
13 Minna	9.62	6.53	258.64	1.55	1.37	1.48	1.48	1.37	1.35	1.25	1.19	1.35	1.013	1.53	1.79	1.394	0.189
14 Nguru	12.9	10.5	342.0	4.07	3.78	4.08	3.46	3.6	3.98	3.87	3.44	3.35	3.15	3.95	4.12	3.736	0.313
15 Oshogbo	7.73	4.48	304.7	1.11	1.64	1.78	1.64	1.39	1.39	1.67	1.67	1.50	1.17	0.97	1.17	1.425	0.255
16 Port Harcourt	4.85	7.02	18.55	2.09	2.36	2.36	3.36	2.25	2.25	2.25	2.42	2.36	2.25	1.84	2.00	2.316	0.354
17 Potiskum	11.7	11.2	414.0	2.84	2.73	3.13	3.65	3.94	4.84	4.00	2.91	2.34	2.16	2.28	3.45	3.189	0.777
18 Sokoto	13	5.25	350.75	4.51	4.64	3.08	3.43	4.78	5.12	4.64	3.38	3.02	2.58	3.73	4.20	3.926	0.792
19 Warri	5.52	5.73	6.1	1.69	1.53	1.78	1.85	1.77	1.80	1.94	2.06	2.08	1.97	1.44	1.43	1.778	0.213
20 Yelwa	10.9	4.75	247.0	2.57	2.29	3.38	4.30	4.41	4.06	3.26	2.85	2.37	2.26	1.92	1.69	2.947	0.891
21 Yola	9.23	12.5	186.05	1.21	1.43	2.00	2.51	2.29	2.19	1.60	1.43	1.22	1.03	1.03	1.21	1.600	0.494
22 Zaria	11.1	7.68	653.9	3.19	2.09	2.09	2.56	2.63	3.58	2.19	2.39	2.14	2.11	2.50	3.01	2.536	0.472

Wind energy potential in Nigeria

Source: J.O. Ojosu and R.I. Salawu " A Survey of Wind Energy Potentials in Nigeria", Solar & Wind Tech vol. 7, No. 23 Pg. 155-167, (1990)

### **3. Wind Potential in Nigeria .... Contd.**

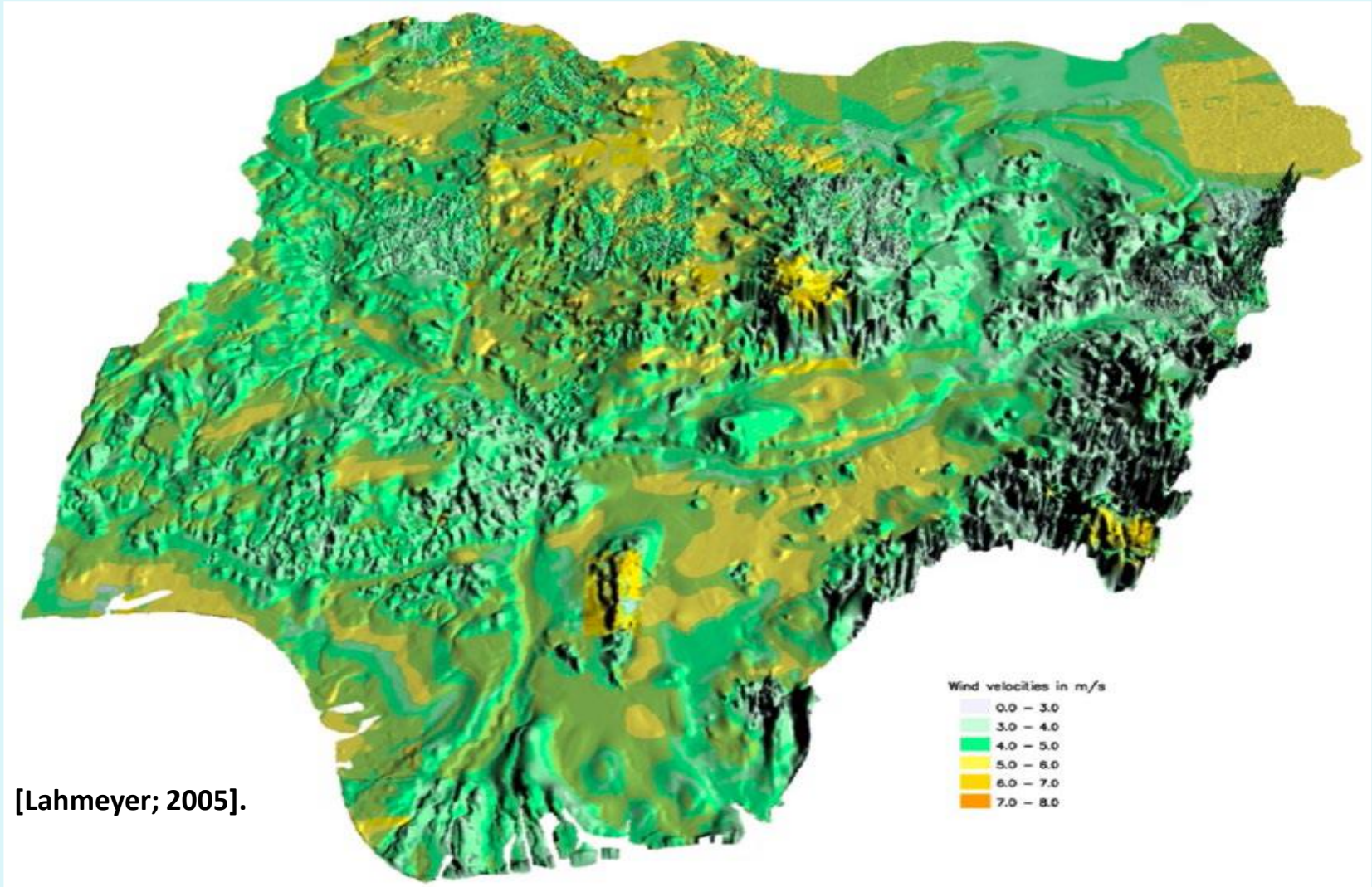


- **The Ministry of Science and Technology has carried out wind energy resource mapping [Lahmeyer; 2005].**
- **This wind mapping project indicated wind speed of up to 5 meters per second in the most suitable locations, which reveals only a moderate and local potential for wind energy.**
- **The highest 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.**

# 3. Wind Potential in Nigeria .. Contd.



## 3D WIND MAP OF NIGERIA 80M ABOVE THE GROUND



[Lahmeyer; 2005].

## 4. **Wind Development Policies/Strategies**



The Federal Government of Nigeria (FGN) has enacted various supportive policies/regulations to encourage private sector's investment in the renewable sector (including wind):

- **Energy Commission of Nigeria (ECN) National Energy Policy (2013)**
- **ECN - Renewable Energy Master Plan (2012)**
- **Nigerian Electricity Regulatory Commission (NERC) Mini Grid Regulation**
- **Rural Electrification Strategy and Implementation Plan (RESIP) (2016)**
- **Nigerian Renewable Energy and Energy Efficiency Policy (NREEEP)**
- **Power Sector Recovery Programme (PSRP) – 2017**
- **Rural Electrification Fund Operational Guidelines (REFOG)**



## 4. Wind Development Policies ..... Cont'd

**The National Energy Policy of the FGN contains specific policy statements on Wind:**

- The nation shall commercially develop its wind energy resource and integrate this with other energy resources into a balanced energy mix.
- The nation shall take necessary measures to ensure that this form of energy is harnessed at sustainable costs to both suppliers and consumers in the rural areas.
- The Nation shall apply global best practices in the wind energy resources

## 4. Wind Development Strategies ... Cont'd



*The National Energy Master Plan (NEMP) contains clear wind development strategies for Nigeria:*

- *Encouraging research and development in wind energy utilization.*
- *Developing skilled manpower for the provision of basic engineering infrastructure for the local production of components and spare parts of wind power systems*
- *Intensifying work in wind data acquisition and development of wind maps*
- *Training of skilled local craftsmen to ensure the operation and maintenance of wind energy systems.*
- *Providing appropriate incentives to producers, developers and consumers of wind power systems.*
- *Developing extension programmes to facilitate the general use of wind energy technology*

# 4. Wind Development Strategy... Cont'd



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

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

Short – 2015  
 Medium – 2020  
 Long – 2030

Source: ECN



## 4. Wind Development Strategy ..... Cont'd



### Targets: Electricity Generation Investment Opportunities

Resource	Investment opportunity
Large Hydropower	About 11,000MW by 2030
Small Hydropower	About 3500MW by 2030
Solar	48,000MW by 2030
Wind	50MW by 2030
Biomass	100MW by 2030

Investments can be in form of Grid-connected electricity, off/mini-grid large scale Solar Plants, Solar Home Systems, Solar Water Pumping, Solar Community Services PV Refrigerators, PV Street and traffic lighting etc.

# 4. Wind Development Strategy... Cont'd



5kW aero generator in Sayya Gidan Gada, Sokoto State



One of the 37 No 275kW Wind to Electricity Machines for the 10 MW Katsina Wind Farm

## 5. Investment Incentives



- The Nigerian Government, through the Nigerian Investment and Promotion Council (NIPC) and other agencies, 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, other are limited to some specific sectors.
- There is the **National Energy Policy** which encourages a diversified energy supply mix to include renewable energy through active private sector participation.

## 5. RE Investment Incentives ..... Cont'd

### *Companies Income Tax:*

- The Companies Income Tax Act has been amended in order to encourage potential and existing investors and entrepreneurs.
- The current rate in all sectors, except for petroleum, is 30 percent (Source: NIPC)

## 5. RE Investment Incentives ..... Cont'd

### *Pioneer Status:*

- The grant of Pioneer Status to an industry is aimed at enabling the industry concerned to make a reasonable level of profit within its formative years.
- The profit so made is expected to be ploughed back into the business.
- Pioneer status is a tax holiday granted 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.
- All Energy Sector investments have this status.
- There is **FGN and World Bank guarantees on PPAs**

## 5. Investment Incentives ..... Cont'd

- ***Feed-in Tariff:*** NERC has introduced feed-in-tariff which is designed to enable producers of renewable electricity sell their power to the grid at a predetermined and cost reflective value with reasonable profit margin.
- **Zero Import Duty for Power Equipment** including renewables.



# 5. Investment Incentives Cont'd



## Feed-In-Tariff

### (i) Large Hydro Plant

	2012	2013	2014	2015	2016
Wholesale contract prices (₦/MWh)	4,898	5,290	5,715	6,174	6,671

### (ii) Small Hydropower (SHP)

	2012	2013	2014	2015	2016
Wholesale contract prices (₦/MWh)	23,561	25,433	27,456	29,643	32,006

### (iii) On-Shore Wind Plant

	2012	2013	2014	2015	2016
Wholesale contract prices (₦/MWh)	24,543	26,512	28,641	30,943	33,433

### (iv) Solar Power Plant

	2012	2013	2014	2015	2016
Wholesale contract prices (₦/MWh)	67,917	73,300	79,116	85,401	92,192

### (v) Biomass Power Plant

	2012	2013	2014	2015	2016
Wholesale contract prices (₦/MWh)	27,426	29,623	32,000	34,572	37,357

Source: NERC (2012): Multi-Year Tariff Order, 1<sup>st</sup> June 2012 – 31<sup>st</sup> May 2017

# 6. Challenges

Investment in the RE sector is however, faced with some challenges:

- **Cost-reflective tariff regime yet to be achieved.**
- **Obsolete and limited transmission and distribution line assets.**
- **Lack of affordable domestic long-term funding facility**
- **High initial investment cost for RE projects;**
- **Inadequate incentives (Fiscal and financial)**
- **Lack of appropriate laws to support incentives**
- **Inadequate human and infrastructural capacities**



## 7. Concluding Remarks

- Nigeria is endowed with huge Renewable Energy Potentials, which are still grossly under-exploited.
- These Potentials can be harnessed through public-private- partnerships to generate electricity, fuels and process heat efficiently, which are vital in driving economic activities.
- With government's strong political will and the incentives available, investors can now come into the renewable sector of the country and invest profitably taking advantage of the large population of, and market in, the nation.

**Thank you  
and  
God Bless**