Economic Feasibility of Integrating 20% Renewable Energy Into the Nigerian Power Generation Mix By 2030

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Aim

- To examine the economic feasibility of integrating 20% renewable into the Nigerian electricity generation mix by 2030

Background

- **Electricity access is crucial for meaningful socio-economic development of any nation.**
- **Nevertheless, about 1.26 billion people worldwide (18% of global population) are without electricity access**
- **In Nigeria, Africa's most populous country, 96 million people (55% of the population) are without electricity access. Overall, 48% of households in Nigeria lacks electricity access**
- **In 2013 Nigeria produces and consumes 28,706GWh and 25,159GWh of electricity respectively, reflecting a T&D of 3,547GWh, averaged 34.1% between 1980-2013**

Figure 1: Nigeria's Power Generation Mix

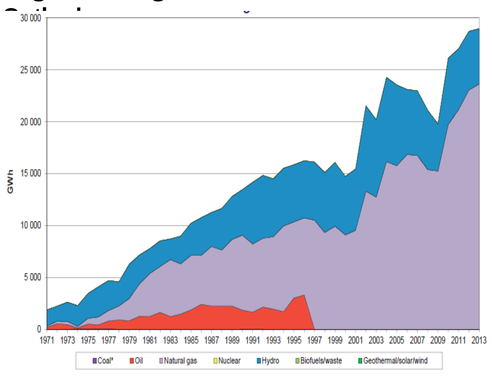
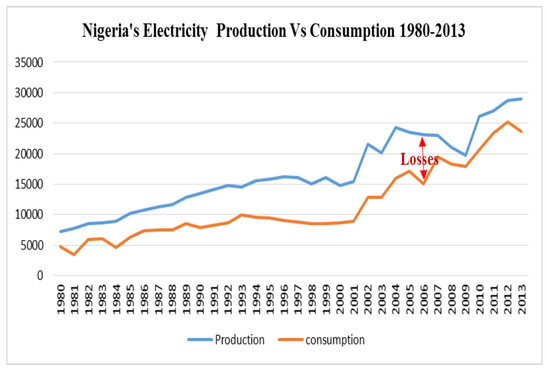


Figure 2: Electricity Generation and Consumption



- **As of May, 2015, Nigeria's net power generation stood at 3,381MW - < 30% of the country's electricity requirement, 12,800 MW**
- **To address this situation, Nigeria targets 20% renewable in its electricity generation Mix by 2030**

Table 1: Nigeria's Renewable Energy Potential

Sources	Capacity
Hydropower, large scale	11,250 MW
Hydropower, small scale	3,500 MW
Solar Radiation	3.5-7.0 Kwh/m2/day
Wind	2-4m/s @ 10m high (annual average)
Fuel wood	13,071,464 hectares of forest land
Animal waste	61 million tonnes/yr

Source: Sambo, 2009 & BP, 2014

Table 2: Nigeria's Renewable Electricity Generation Targets (MW)

Resource	Medium term 2020	Long term 2030
Hydro (LHP)	4549.00	4626.96
Hydro (SHP)	1607.22	8173.81
Solar	1343.17	6830.97
Biomass	631.41	3211.14
Wind	57.40	291.92
All Renewable	8188.20	23134.80
All Energy Resources	45490.00	115674.00
% of Renewab	18%	20%

Source: NREEEP, 2015

Methodology

- **The study employs scenario-based energy-environment modeling tool 'Long-range Energy Alternative Planning' (LEAP); developed by the Stockholm Environment Institute, USA**
- **Four scenarios developed and analysed include**
  - **Reference Scenario**
  - **Renewable Electricity Target Scenario**
  - **Energy Efficiency Target Scenario**
  - **Economic (Low, Medium & High) Growth Scenario**

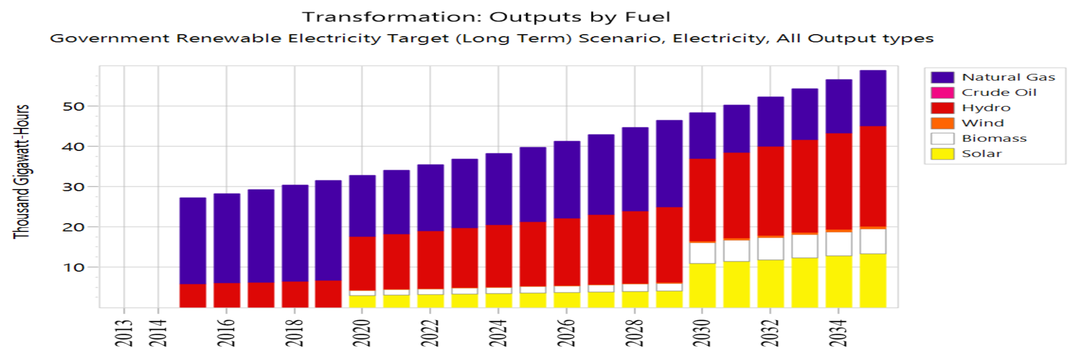
Table 3: Key variables for modelling the Nigeria Electricity System in LEAP

Key variable Assumptions	Value in 2013	Reference
GDP (Billion constant 2005 US$)	1,833.1	WDI, 2015
GDP growth rate (%)	5.4	WDI, 2015
Population (million)	172.8	WDI, 2015
Population growth rate (%)	2.7	WDI, 2015
Household Size (persons)	4.13	NESP, 2015
Urbanisation rate (%)	46.1	WDI, 2015
Electrification urban (%)	55	IEA, 2014
Electrification rural (%)	37	IEA, 2014

Result

Based on the proposed installed capacity additions in Nigeria by 2020 and 2030, the electricity generation is forecasted by LEAP as follows

Figure 3: Nigeria's Electricity Generation Forecast



About 27,262GWh of electricity generation (from natural gas and hydro) in 2015 is expected to increase (with proposed 20% renewable addition) to 32,803GWh in 2020 and 48,325GWh in 2030.

Based on the considered key socio-economic parameters in Table 3, the future electricity consumption under different scenarios is as follows

Table 4: Electricity Demand Projections Per Scenario (Thousand GWh)

Scenarios	2013	2014	2015	2020	2025	2030
Energy Effiency	23.5	24.2	24.8	28.1	31.7	35.4
High Economic Growth	23.5	24.6	25.5	31.2	38.7	48.3
Low Economic Growth	23.5	24.4	25.1	29.7	35.4	42.3
Renewable Electricity Target	23.5	24.5	25.3	30.4	36.9	44.8

The above forecasted production estimate is expected to meet the demand in all scenarios except for HEG scenario where supply shortage of about 0.5GWh is expected by 2030. Hence, highlighting the need to bridge this gap through capacity expansion or adoption of energy saving mechanisms

Also, the result reveals that the proposed 20% renewable integration would significantly reduce the country's CO_2 emission from 10Mt in 2015 to 7.1Mt and 5.3Mt respectively by 2020 and 2030

In a bid to access and compare the economic feasibility of the proposed renewable options in Nigeria, the levelized cost of electricity (LCOE) metric is used and the result is tabulated below:

Table 5.: Estimated LCOE for Selected Renewable Technologies in Nigeria

Name	Capital Cost (US$/kW)	Fixed O&M cost (US$/kW-yr)	Variable O&M cost (US$/kW)	Economic Life (Years)	Capacity Factor (%)	Estimated levelized cost ($/kWh)
Large Hydro	1,870	75	15	30	0.55	**0.05**
Small Hydro	2,990	160	35	30	0.50	**0.09**
Solar PV	2,590	25.8	-	20	0.25	**0.12**
Wind	1,540	38.7	5.5	20	0.39	**0.08**
Biomass	**2,160**	**114.8**	**26.7**	**25**	**0.80**	**0.04**

From the result, the most economically feasible renewable solution in terms of cost per kWh is biomass, followed by large hydro, wind and small hydro while solar PV is seen as the most expensive option.

The high LCOE of solar PV signifies that the technology might not be economically viable through normal tariffs, hence requires appropriate subsidies in the form of feed-in tariffs to create favourable environment for potential investors

Conclusions

- The proposed 20% renewable power generation in Nigeria by 2030 seems economically feasible but will require huge investment and supportive mechanisms.
- The LCOE estimation reveals biomass, hydro and wind as the most cost effective options
- Finally, the proposed renewables deployment represents the vital route to curtail Nigeria's lingering electricity crises and reduce greenhouse gas emissions.