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An assessment of renewable energy readiness in Africa: Case study of Nigeria and Cameroon

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Abstract:

Africa is blessed with abundant energy sources that can promote economic growth and provide sufficient capacity to meet up with the future electricity demand. This paper evaluates the progress made in renewable energy (RE) development in Nigeria and Cameroon together with the roadmaps for future implementation. Since the early 2000, Nigeria has identified RE as an additional source to improve electrical power generation, while Cameroon is yet to have a defined policy for RE development. Presently, in both countries, RE is being developed for empowering the local economies, but the RE incorporation to the national grid is yet to be implemented at a greater scale. Since Nigeria and Cameroon have similar climatic conditions, they can benefit from each other through greater cooperation in the RE sector. For the two countries, there is high solar

irradiation and excellent wind speed that can be effectively utilized for electricity generation. For all these to benefit both nations, there is a greater need for good leadership and good governance.

Keywords: Renewable energy; Nigeria; Cameroon.

List of acronyms

Acronyms	Descriptions
Btu	British thermal units
e-kiss	energy-keep it simple and safe
ECN	Energy Commission of Nigeria
IEA	International Energy Agency
IEO	International Energy Outlook
NASENI	National Agency for Science and Enginnering Infrastrucuture
NCERD	National Centre of Energy Research and Development
NEM	National Energy Master Plan
OECD	Organization of Economic Cooperation and Development
PIB	Petroleum Industry Bill
PV	photovoltaic
RE	renewable energy
SERC	Sokoto Energy Research Centre
SHP	small hydropower
SSA	Sub-Saharan Africa
UNDP	United Nations Development Programme

Introduction:

Global warming and continuous energy demand in the world market coupled with the rise in energy price have significantly drawn attention to the need of renewable energy (RE) resources. Africa as a continent is blessed with abundant energy sources, but imbalance between electricity production and generation still remains an issue in Sub-Saharan Africa (SSA) countries [1]. Based on the International Energy Agency (IEA) information, the sub-Saharan Africa has mass population without access to adequate electricity [2]. These are due to disparity in the energy development across the whole continent. In examining Africa modern energy consumption with regions such as Middle East, North America, Latin America and Europe, it is obvious that Africa has one of the lowest per capital consumption rate of energy [2,3]. This among other things is due to the fact that Africa relies mostly on traditional biomass and hydropower energy [3]. Africa as a continent has abundant RE potential, but has not been fully harnessed. Amongst the reason for the slow uptake in RE are high capital cost of initial financial investment as well as lack of adequate knowledge regarding the benefits of RE. Nigeria and Cameroon are among the African countries that are slowly striving to include RE in their future energy development.

Based on the International Energy Outlook (IEO) 2013 report [3], the world energy growth will be 56% between 2010 and 2040, with an increment of 1.5% per annum. In the reference case (see Table 1 and Fig. 1), the total energy demand in non-OECD (Organization of Economic Cooperation and Development) countries - in which Nigeria and Cameroon belong to - had increased by 90% compared with a rise of only 18% in OECD countries [3].

Table 1: World marketed energy consumption based on country grouping, in quadrillion Btu, from 2010 to 2040 [3].

Region	2010	2015	2020	2025	2030	2035	2040	Mean annual percent change
OECD	242	244	255	263	269	276	285	0.5
Americas	120	121	126	130	133	137	144	0.6
Europe	82	82	85	89	91	93	95	0.5
Asia	40	41	43	44	45	46	46	0.5
Non-OECD	282	328	375	418	460	501	535	2.2
Europe and Eurosia	47	50	53	57	61	65	67	1.2
Asia	159	194	230	262	290	317	337	2.5
Middle east	28	33	37	39	43	46	49	1.9
Africa	19	20	22	24	27	31	35	2.1
Central and South America	29	31	33	35	39	42	47	1.6
World	524	572	630	680	729	777	820	1.5

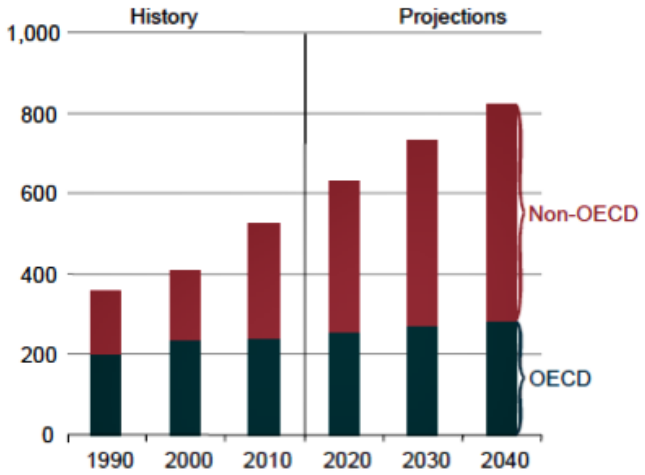

Fig.1: World energy consumption, in quadrillion Btu for the period from 1990 to 2040 [3].

Fig. 1 shows that the total energy in the world rises from 524 to 820 quadrillion British thermal units (Btu) between 2010 and 2040 [3]. This is driven by strong economic and population growth in non-OECD contrasting OECD countries with slow economic growth and population expansion. Fig. 2 shows the outlook of world energy consumption by energy source. There is an increase over the time horizon. Liquid consumption rises yearly at the rate of 0.9% from 2010 to 2040, with a yearly total energy demand increase of 15% [3]. Nuclear and renewables are the fastest growing source of world energy at average growth of 2.5% per year [3]. Fossil fuel continues to be the most source of world's energy supply [3]. It is expected that by 2040 and beyond, liquid fuel, coal and natural gas will continue to supply most of the energy of the world [3].

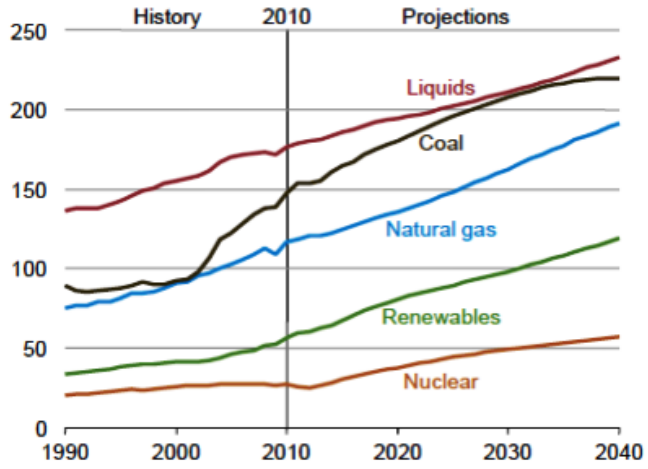

Fig.2: World energy in quadrillion Btu, utilization by fuel type, 1990-2040 [3].

According to the IEO reference case [3], there is an increase by 93% in the world's net electricity consumption from 2010 to 2014. For non OECD countries, which include Nigeria and Cameroon, there is lack of access to electricity by many people as compared to the OECD countries. However, net electricity generation in non-OECD countries rises at an average rate of 3.1% annually led by India and China. As the world battles with security concern with environmental consequences, many governments around the world are designing policies which support the development of RE sources.

For that effect, RE has been the fastest growing energy source of electricity. Coal fired generation has been the leading source of world electricity generation through 2040 (see Fig. 3). With the exception of coal, other non renewable like nuclear and natural gas are amongst the fastest growing source of energy in the world. Despite the interest in RE across the world, non OECD countries like Nigeria and Cameroon are still lacking behind in developing appropriate policies and infrastructure for renewables.

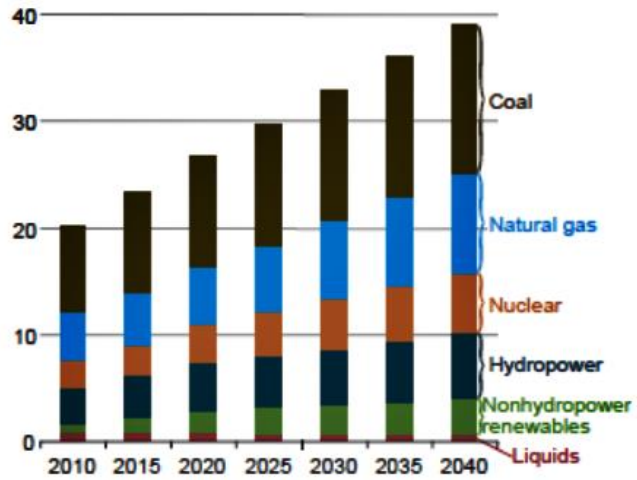

Fig. 3: World net electricity generation by energy source 1990-2040 [3].

There are several issues hindering the progress of RE in developing countries like Nigeria and Cameroon. The major barriers that are affecting these countries and other African countries are: (i) policy regulation and institutional; (ii) information and technical capacity, and (iii) financial [1]. Furthermore, there is low level of local and international investments in RE due to lack of awareness about the benefit of RE coupled with the high cost of capital investment. For international investors, the image of Africa regarding investment has not been really good. This is due to corrupt practices and lack of good governance. Currently, there is no consistent policy and regulatory framework with regard to RE in Africa, mainly because of an absent of leadership from the government in accelerating the implementation of this policies, and therefore affects private and industrial sectors to extend their investment in the area of RE. This also leads to inconsistency in budgetary allocations for RE across Africa. There is also no institutional

development to cover the technical and economic aspects of the development. As for the utility companies in most African countries, many are not accepting the incorporation of RE sources such as solar and wind into the grid, possibly because of their small power generation. Being a very new area, there is inadequate knowledge regarding the testing and maintenance of the RE structures, which also means lack of adequate workforce to carry out proper evaluation. On top of that, there is a lack of accurate data on RE especially in solar and wind.

This paper provides an up-to-date analysis of RE readiness in Nigeria and Cameroon, together with the challenges that may hinder the smooth implementation of the RE policies in both countries. Section 1 is the introduction. Section 2 describes the geographical location for Nigeria and Cameroon within Africa while Section 3 reviews the status of RE in both countries. Afterwards, Section 4 evaluates the RE potentials in both countries and subsequently examines the policies made by both countries regarding RE in Section 5. Section 6 is the conclusion and way forward for the two countries

2. Geographical location of Cameroon and Nigeria.

Nigeria is located in West Africa, bordered by three countries i.e., Niger to the North, Cameroon to in the East, Benin Republic to the West and the Atlantic Ocean to the South. Nigeria lies within latitude 4.32˚N and 14˚N and Longitude 2.72˚E and 14.64˚E as presented in Fig. 4, with a land area of about 924,000km^2. Nigeria has a population of 165 million inhabitants making it the most populous countries in Africa [4]. There are abundant energy resources in the country such as coal, crude oil, natural gas etc [4]. The county's economy largely depends on crude oil, making it among the top 10 crude oil producing country in the world and was the world's 4th leading exporter of liquefied natural gas in 2012. However, Nigeria oil production has been hindered by insecurity and supply interruption, whereas the natural gas sector is limited by the lack of infrastructure to monetize the gas that is presently burned off [5].

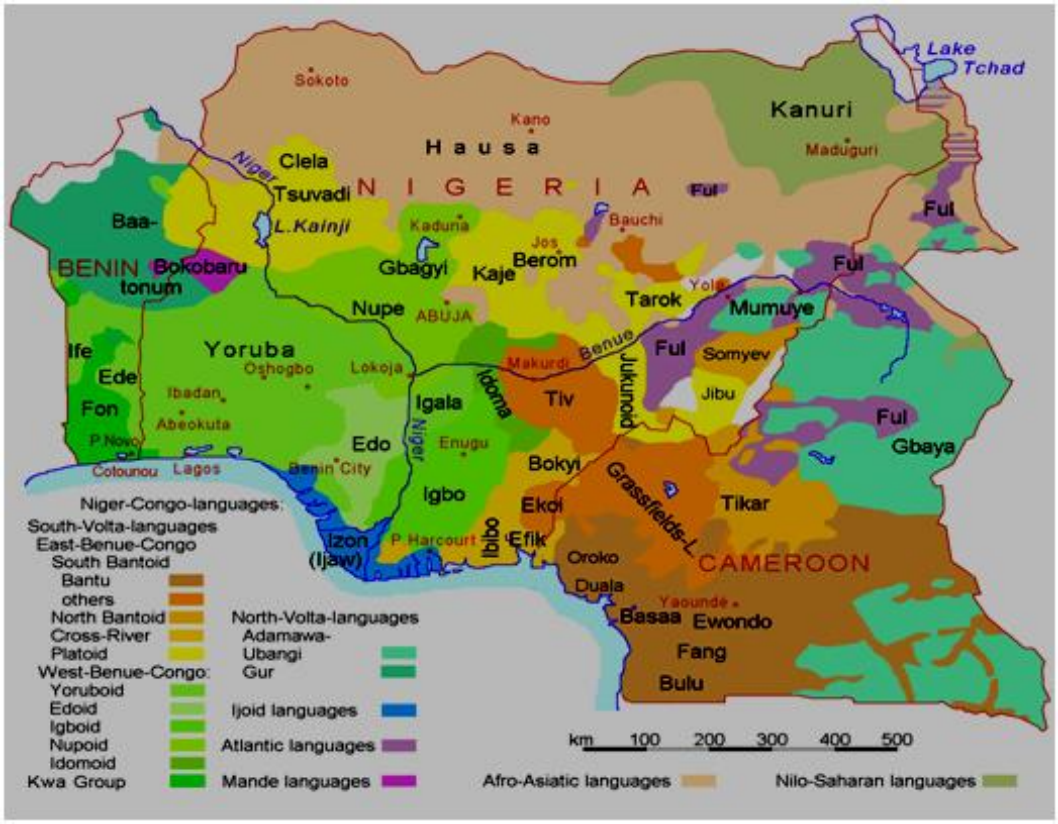

Fig. 4: The map of Nigeria and Cameroon [6].

On the other hand, Cameroon is a central African country, surrounded by Nigeria to the west, Republic of Chad to the North, Central African Republic to the East and Gabon to the South as shown in Fig. 4. Cameroon is Africa in miniature and diverse. Cameroon has the highest population among the central African nations. The population of Cameroon is 20 million and is growing by approximately 2% per year [7]. Unlike Nigeria, Cameroon enjoys political and social stability [8]. The major sources of energy in Cameroon are coal petroleum, hydropower, bio fuel and waste. These sources of energy have not been fully utilized.

3. The current situation of conventional energy in Nigeria and Cameroon

As stated previously, Nigeria has enormous energy sources ranging from the conventional ones such as coal, oil, gas, biomass, hydro. However, there are abundant potentials in solar, wind, nuclear, ocean, geothermal and fuel which have not been fully utilized [9]. Back in 1960, energy untilisation in Nigeria was predomently house hold namely fuelwood, charcoal, residues and agricultual waste. Commercial utilization of fuel was coal used by the rail industry to generate power. Since then, there is swifting change in the energy consumption. Presently, natural gas account for 5% of the energy consumption, while traditional biomass and waste acount for 83%, oil consumption is about 11% and hydropower is at 1% (see Table 2). Coal has declined drastically to an insignificant stage. Similarly, in Cameroon, the fundamental energy sources are coal, oil, hydropower, biofuel and waste [10]. Oil accounted for 27.2% of primary energy consumption, natural gas (3.7%), hydro (5%) and biofuels with waste (64.10%) (see Table 2). Among these energy sources, hydro power is the dominant electricity source with little attention paid to the other renewables like solar, wind, geothermal. Cameroon possess the highest hydroelectric power stations after The Democratic Republic of Congo [11].

Table 2: Percentage energy consumption in Nigeria and Cameroon [10].

Type	Nigeria	Cameroon
Oil	11%	27.2%
Natural gas	5%	3.70%
hydro	1%	5%
Biomass and waste	83%	64.10%

3. 1 Electricity demand and supply in Nigeria and Cameroon

The net electricity generation per capita in Nigeria is among the lowest in the world. The demand is far higher than the electricity generation resulting to regular power outages, load shedding and over reliance on individually owned generators. In order to

improve the power generation and attract local and foreign investors, the government of Nigeria recently embarked on privatizing the power holding company of Nigeria.

According to the *Road Map for Power Sector Reform* in Nigeria [12], the generation capacity for Nigeria was 6000MW as at 2012. Out of this, 1270MW was from hydro and the remaining 4730MW was from fossil fuels. Net electricity generation was also estimated at 26 billions kWh. Harvard paper [13] estimated that 30% of electricity was provided by private generation and most business purchases generators to do business during power blackouts, which is very costly. In addition, the majority of Nigeria solely depends on local biomass for household energy consumption such as wood, waste and charcoal for heating and cooking.

Recent World Bank Report [14] shows that Nigeria experienced power failure on average for about 46 days per year between 2007 and 2008. Currently, the power demand is atributed to the rise in population coupled with low investment in the energy sector. There is also poor maintenance of the power facilities and insuficient fuel that continue to hinder the power sector development.

The government of Nigeria planned to increase the generation to about 20000MW by 2020. In order to achieve this target, several plans have been made over the past decades but nothing has been achieved and therefore the government has put the Nigerias power holding company for sale for both local and international investors.

As of 2015, Cameroon electricity generation capacity is at 817 MW which hydroelectricity contributed to 88% and the remaining is from thermal power generation. The main hydroeletricity power stations are located or are built within the Sanaga Rivers while others are located in the other parts of the country for example the Lagdo station in the north near Garua. The demand for electricity in Cameroon is estimated to reach 1455MW in 2014 and almost 5000MW in 2020. According to Ayompe and Duffy [15], the Cameroon government planned to install 2500MW of hydroelectic power between 2012 and 2020 and 298MW from thermal power plant by the year 2013, but this has not been fully implemented to date. Cameroon electricity is mostly depended on hydroelectric power stations which is not evenly distrubuted, with only 20% of the population having access to the national grid. Those who utilize the electricty are those in the major cities while those at rural areas are not well connected.

Based on the above analysis, it is obvious that Nigeria and Camerron are facing challenges regarding the electricity sector, whereby the demand for electricity exceeds the supply. Although several measures are put in place to improve the situation, so far there is no tangible result. Therefore, it is a clear indication that RE can play a role in meeting the future energy demands of these two countries if both governments can fully utilize the abundant RE potentials

4.0 Renewable Energy potentials in Nigeria and Cameroon.

4.1 Solar Energy

There is much variation in solar radiation across Nigeria, but it is higher in the northwest and northeastern part of the country. However, Nigeria has adequate solar radiation that can generate electricity which can be fed into the national grid, but this have not been utilized (see Fig.6). The optimum solar radiation in Nigeria is about 7000 Wh/m^2 in the Northern part of the country and about 4000 Wh/m^2 in the southern part of the country per day [16]. Many researches have been carried out to investigate the solar potentials in Nigeria and almost all of them shows the huge potentials that can be utilized [17,18]. Efforts of harnessing the solar potentials in Nigeria is handled by the Energy Commission of Nigeria (ECN) and is supported by the National Agency for Science and Enginnering Infrastrucuture (NASENI), through three research institutes of ECN i.e., Sokoto Energy Research Centre (SERC), National Centre of Energy Research and Development (NCERD) based in University of Nigeria, Enugu and NASENI Solar Energy Ltd. Due to the frequent power failure in most part of the country, solar energy is uitilized for powering street lights in some states in the north e.g in Sokoto (see Fig. 6(a)). There are solar based photovoltaic (PV)-lightning in schools and homes across the country. There are also solar based water pumping and lighting in hospitals. There are huge research outputs from the SERC but they are only started to be implemented in a small scale. The SERC has developed solar kilishi dryer, solar water heater, solar distriller, solar powered water pumping system, box type solar cooker, medium scale solar dryer system, 500L water heater supplying hot water requieremnt to a village clinic.

NASENI has established a solar panel manufacturing plant at Karshi, Abuja. The plant has a capacity for the production of 7.5 MW solar panels per annum to help Nigeria meet up with its future energy demand. There is a need for urgent investigation into the possibility of injecting the solar energy into the national grid. Though there may be high initial capital cost for the implementation of the solar technology, the benefits are enormous. Recently in Nigeria, the government signed a memorandum of understanding with New Technology Industry based in the United states to provide 1200MW of utility scale solar PV projects within Nigeria to be fully functional within the next 2 years with an investment of over USD 2 billion [19].

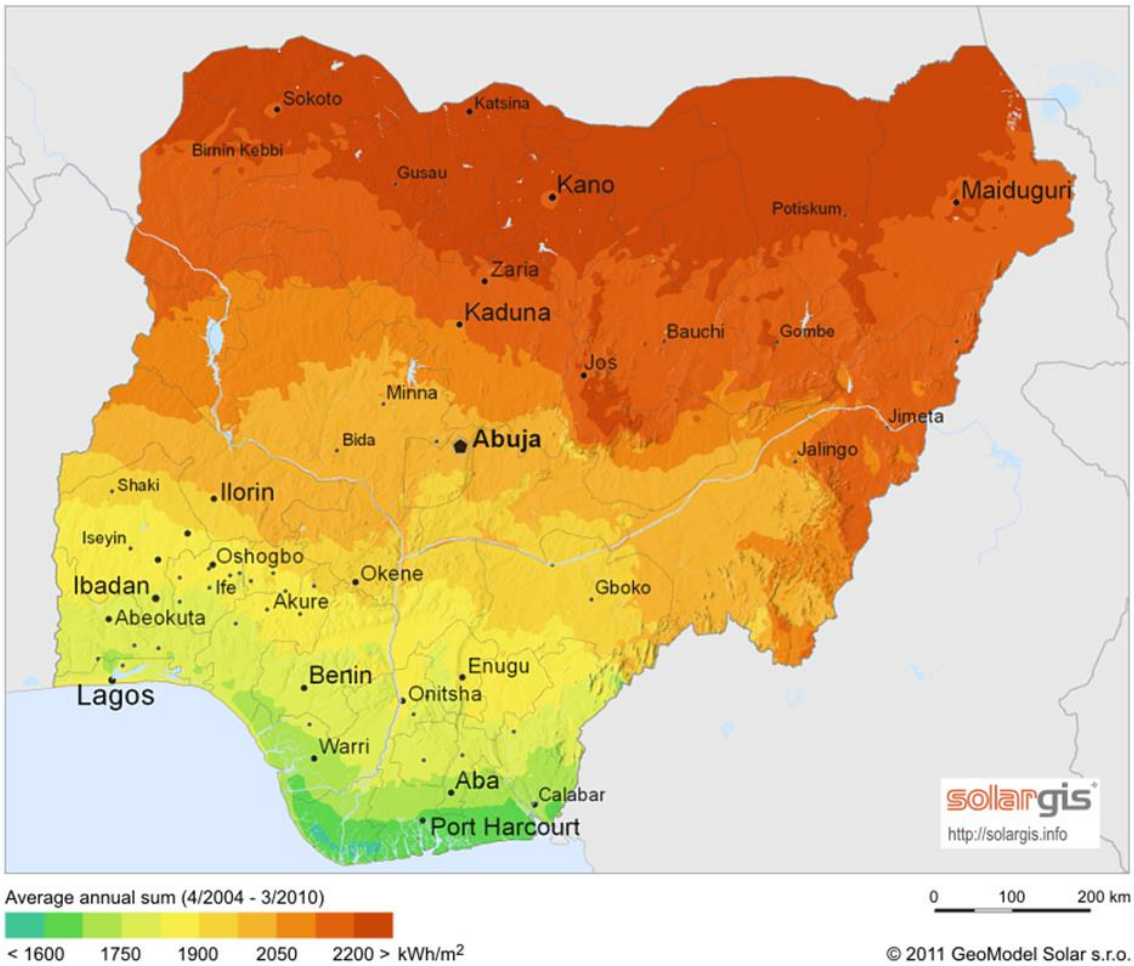

Fig. 5: Solar irradiation map of Nigeria [20].

Fig. 6: Solar PV utilization, where; (a) solar PV at SERC permanent site in Nigeria, and (b) solar powering streets in Yaounde area of Cameroon [8,16].

Similar to Nigeria's situation, Cameroon has huge solar potentials which has not been harnessed. Though in Nigeria, there is support for research and development in these sector by the governmnet, Cameroon suffers the oppposite in which there is almost little or non-existent support from its government. Only recently, there is solar powering of street lights in Yaounde (see Fig. 6(b) for example) and Doula areas but there were many factors that hinders this development, including: (i) there is poor maintainance of the solar facilities; (ii) the government of Cameroon is not commited in boosting this sector, and (iii) there is no clear policy on solar technology that can encourage both local and international investors into the sector. In most part of the country, the mean solar irradiance is approximately 5.8kWh/m^2/day [21] (see Fig. 7). Compared to Nigeria, Cameroon can benefit more from solar energy due to low population and political stability. Of recent, Cameroon installed 'e-kiss' (energy-keep it simple and safe) mobile off-grid PV systems from Antaris solar ESI-Africa [22]. This technology can generate

electricity on a standalone basis. It can supply up to 2000W which is adequate for rural areas that do not have reliable electricity supply from the national grid.

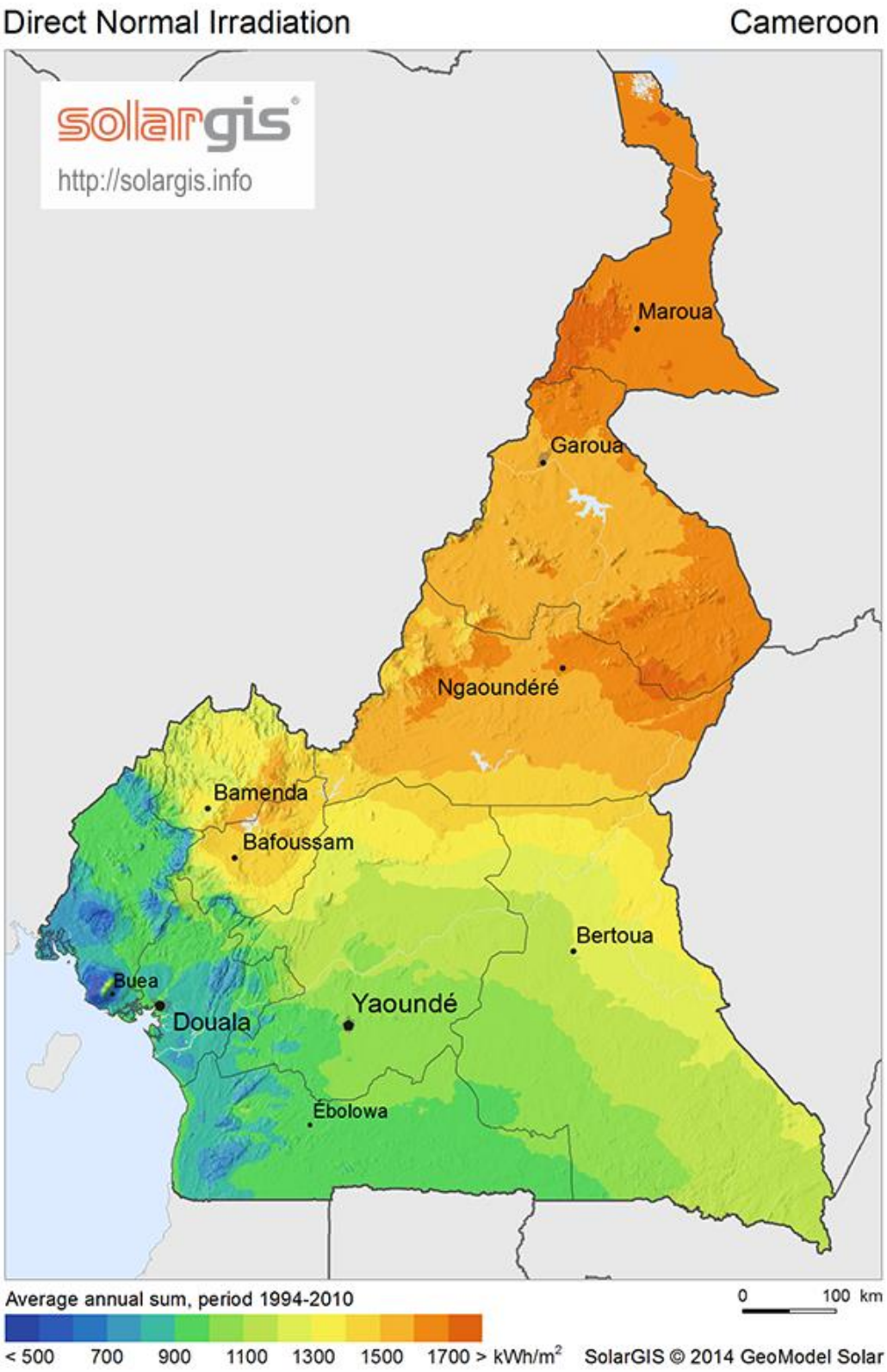

Fig. 7: Map showing the irradiation pattern across Cameroon [20].

4.2 Hydropower

Hydropower remains the main source of power generation in both Nigeria and Cameroon. The reason for hydropower being the main source of energy for both countries are due to large rivers and waterfalls in both countres. Some of the advantages of hydropower generation include easier environmental impact assessment, minimal construction works and possibility of fishing and irrigation. It is also easier to invest in hydropower technology than in other some other RE, because the other technologies have high initial capital cost of implementation and may supply only limited energy.

From a survey carried out in 1989 over 12 selected states of Nigeria, it was observed that up to 734.2MW of small hydropower (SHP) capacity can be realized from 277 sites [23]. It is expected that the potential would rise, when the rest of the country is investigated. Currently, more sites are being studied and it is anticipated that the total SHP potential could reach as high as 3,500 MW.

Nigeria has about 239 large, medium and small dams. About 40 of these dams already have hydropower components in them (powerhouse, penstock etc.) Hydropower can also be integrated into all the others dams currently used for irrigation and water supply.

Currently, in Nigeria the hydropower potential is estimated to be 14,750MW [4]. However, only 14% of this potential has been utilized. The major hydropower plants in Nigeria are the Kainji, Shiroro and Jebba. Hydropower in Nigeria is hugely underexploited and there is a need for the government of Nigeria to take the leading role in making sure that such potential is exploited. Some of the equipment in the power generating plants are ageing and not properly maintianed. There are also several assessent of mini and micro hydro potentials across the country that have not been implemented. If the hydropower potentials are fully utilized, it can reduce the fiscal debt of the country.

Subsequently as mention previously, hydropower remains the source of energy in Cameroon. Hydropower potential for Cameroon is curently estimated at 23GW with production potential of 103 TWh per year [24], but it remains unutilised. The major hydropower stations in Cameroon are namely Sogloulou, Edea and Lagdo. There are also smaller hydropower potentials across Cameroon that had not been exploited. There is

need for the government to take a leading role in making sure that those potential power stations are developed, in order to serve energy to both the rural and the urban dwellers of Cameroon.

4.3 Wind Energy

In Nigeria, the wind speed ranges from 4.0 to 5.12 m/s in the northern part of the country, and from 1.4 to 3.0m/s in the south [25]. According to the ECN, the total wind energy reserve are at 10 m height and may vary from 8 MWh/yr in Yola to 51 MWh/yr in the area of Jos and may well reach as high as 97 MWh/yr in Sokoto [26]. Currently Nigeria is yet to fully exploit wind energy potential for the benefit of its citizens and also to integrate the wind energy into the national grid. There is a need for a robust policy with regard to wind energy so that private institutions can also take part in the development of this sector. Research and development in wind energy is currently in existing. The SERC has been saddled with the responsibility for carrying out research and development in wind power station [27]. A 4kW wind turbine has already been installed and integrated with 10kW PV power plant to serve as a hybrid system at Danjawa village as shown in Fig. 8. However, there is low awareness regarding the viability of wind energy as a good potential for electric power generation in addition to lack of funding.

In Cameroon the wind energy speed ranges from 2 to 4m/s at 100m height [21]. The only favorable site for wind energy in Cameroon are in the North and some costal areas. There are some wind turbines installed in Douala especially in hotels and there are some potential zone for wind energy in Ngoundere and Moudou lake area, but this has never been investigated. Recently wind electric pumping system has been installed at Ndoh Djutissa (see Fig 8b). The Cameroon metrological services reported that wind speed are not sufficient for the development of wind turbines in some areas but this have not been fully investigated.

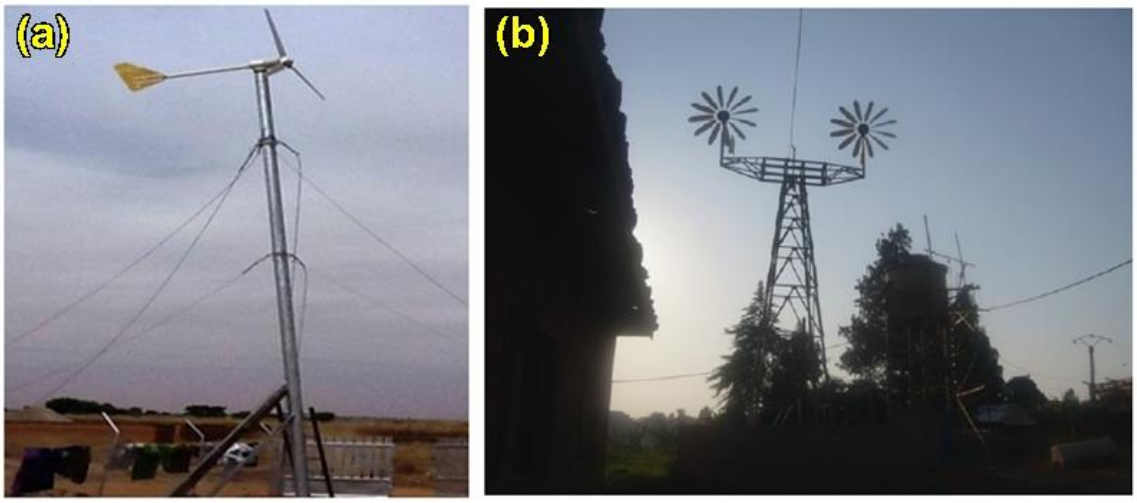

Fig. 8: Wind energy utilization, where (a) 4 kW wind turbine installed at Danjawa village in Nigeria [27], and (b) Wind electric pumping system at Ndoh Djutissa in Cameroon [28].

4.4 Biomass

Biomass refers to various materials obtained from plants and animals, that can be used for the formation of useful energy in different forms and purposes [29]. Several types of biomass exist such as fibre biomass, organic fertilizer biomass, chemical biomass etc. The by-product of biomass if not properly handled, can have serious effect on social and environmental public health.

Currently, Nigeria is blessed with great biomass resources such as agricultural crops, charcoal, wood, shrubs, forestry waste, grasses, community and manufacturing activities, and aquatic biomass [4]. Nigerias biomass resources are predicted at 8×10^2 MJ [30]. Fuelwood is used by many Nigerians for cooking, heating and other house hold purposes especially the rural duwellers. Huge potentials exist in variety of biomass resources in Nigeria which can be converted into technologies that can be helpful to the citizens. Nigeria is ranked high in the production of energy crops such as palm oil, casava, sesame and soybean which can be used for biofuel. According to Abila [29], Nigeria has the capacity to be a leading biofuel exporter, and that the adoption of biofuel in the country can ease the financial strain and burden on fossil fuel subsidies and also

enhance the local source revenue. Due to huge population of Nigeria, municipal solid waste can be useful as cellulosic material for biogas production.

Compared to Nigeria, Cameroon is ranked the 3rd largest biomass potential with 25 millions hecters of forest covering its territory [31]. Biomass sorces are categorized into agricultural, wood, animal sources, waste stream from timber and forest. However, overdepency on this source of energy for lightning and heating especially by the rural dwellers has led to an excessive deforestation. Palm oil has also been utilized as a source of energy which has also led to deforestation with serious environmental effects. Abanda [32] attests to the fact that in remote area of the country, firewood has been exhausted without being restocked.

5. Energy policy

A broad and articulate energy policy is vital in leading any country towards effective utlization of its resources. For socio-economic growth of any country, not only the existence of the policy that is important, but the policy makers is also an essential element in the policy implementation.

5.1 Energy policy in Nigeria

The government of Nigeria approved the National Energy Policy in April 2003, that addresses issues related to the challenges faced in the energy sector. This policy incorporates issues related to the demand and supply of energy, the production of energy, research and development, RE development of manpower, nuclear energy, energy databank, energy efficiency and global cooperation [33]. The ECN, through the National Energy Master Plan (NEM), was tasked with the responsibility of implementing and monitoring strict compliance with the energy policy plan. Ten years after the NEM was written and approved, some amendments have taken place in the national and international energy stages. For instance, the tabling of Petroleum Industry Bill (PIB) in the Nigerian petroleum sector, the discovering of crude oil in commercial quantities by some neighboring nations, the exploration of shale oil and shale gas in major oil and gas

consuming countries and the deregulation and privatization of the electricity sector. Furthermore, more attention is being given to the advancement of RE worldwide, in order to engineer sustainable growth. Recognizing the above, the ECN initiated the review of the National Energy Policy. The ECN therefore approached the United Nations Development Programme (UNDP) for support and it was granted and reviewed in 2013.

In the NEM, for every economic sector, there are detailed programmes and timeline for every startegy inorder to ensure effective implementation. Thess timelines are categorized into short term (2006-2009), medium term (2010-2015) and long term (2016-2030) [34]. This is important for early correction of set objectives within the time span.

The policy mentioned among others, that the oil shall continue to play vital role in nation building. There is need for expansion of oil reserve base, and the pronotion of oil conservatives. There should also be wider distribution of oil products throughtout the nation for enhancing socio-economic activities. There is also plan for exploration of natural gas together with research and development. It was identified that bitumen and sands can significantly help in the Nigerias energy mix. Bitumen emulsion can be useful for power generation and in iron and steel production. The Nigeria's Energy Policy also mentioned that the coal production can be enhanced but several challenges exist which need to be properly addressed. There is low production of coal mines together with the lack of cost effective transportation system. To address these challenges, the policy recomends that there is need for privatization, research and development relating to coal industry, identification of coal export markets etc. There is also plan for nuclear energy technology in power production which will require some incentives to to attract experts in nuclear technology and also collaboration with the International Atomic Agency.

The major issue hindering the RE development in Nigeria have been identified. These include unidentified demand and lack of legal framework to attract international investors into the sector [33]. The policy provides the aims to address these constraints by adopting the following strategies.

- Huge investment in research and development.
- Empowering local bussiness capabilities

- Creating industries for the production of raw materials for RE facilities and spare parts.
- Educating local and urban dwellers on the prospects of RE as a form of heating and electricity supply.
- Determining the current economic reforms.
- Establishing standards for RE ssytems
- Creating RE fund.

Based on the above policies, a compulsory RE target have been developed on a short, medium and long term basis as shown in Table 3.

Table 3: Future Renewable Energy supply productions in Nigeria [34].

Resource	2012	Short	Medium	Long
Hydro (LHP)	1938	4,000	9,000	11,250
Hydro (SHP)	60.18	100	760	3,500
Solar PV	15.0	300	4,000	30,005
Solar Thermal	-	300	2,136	18,127
Biomass	-	5	30	100
Wind	10.0	23	40	50
All Renewables	2025.18	4,628	15,966	63,032
All Energy Resources	8,700 (installed Generation Capacity)	47,490	88,698	315,158
% of Renewables	23%	10%	18%	20%
% RE Less LHP	0.4%	1.3%	8%	16%

5.2 Energy policy in Cameroon

Unlike Nigeria, Cameroon has no overt energy policy for the public to see. The earliest energy policy in Cameroon was introduced in 1990 but it was not implemented. In 1998 another policy on energy was developed which only focussed on hydroelectric power. In 2005 the Ministry of Energy and Water attested to the ongoing development of a new energy plan which would be developed by 2030 [35]. The vision 2035 by the Cameroon government is also geared towards investing in RE to increase energy independence and economic growth of Cameroon. Thus, there is no clear energy policy for Cameroon and to this effect, Tansi [36] stressed that there are no guidelines in Cameroon relating to RE alone, but there are laws passed by the Cameroonian government in dealing with energy of which RE is incorporated.

6. Conclusion and the way forward for Nigeria and Cameroon's RE

This paper presented the latest evaluation of the RE progress made by both Nigeria and Cameroon. These two neighbouring African countries have huge RE potential that have not been developed. For both countries, the electricity demand is higher than the supply and this is attributed to the rise in population. Nigeria has already developed policy roadmaps for RE implementation while Cameroon is yet to develop similar policy which can attract foreign and local investment in the RE sector. In Nigeria, there are several implementation problems hindering the execution of the current Nigeria RE policy. These include unidentified demand and lack of legal framework to attract foreign investors into the RE sector.Despite these challenges, it is fair to say that Nigeria has taken a major step toward adopting renewables in the future energy mix of the country. Nigeria has established research and development institutions relating to RE, which Cameroon can create linkages for development. The SERC in Nigeria, which is responsible for solar and wind energy research carried out by many researchers and have started yielding results could be one example that can be explored by Cameroon. The SERC has developed solar, solar water heater, solar distriller, solar powered water

pumping system etc. NASENI has already established a solar panel manufacturing plant at Karshi, in Nigeria. There are a number of ongoing assessments for mini and micro hydro potentials in Nigeria. At the moment, Cameroon is only concentrating on hydro power development, despite the abundant of other RE sources to tap into. There are also solar panel installations for powering street lights in some part of the country, e.g. Yaoundé and Douala.

There are several challenges facing both Nigeria and Cameroon RE development. Despite having a high solar irradiation especially in the northern part of Nigeria, the current security situation definitely causes a setback in solar development. There is high capital cost for the initial implementation, lack of adequate skills in the sector and lack of political will from the government. Though, solar PV has been applied for street lighting in some part of Cameroon, poor maintenance has crippled the process.

For both Nigeria and Cameroon that have teaming populace having lack of electricity access, several opportunities exist for RE application that can increase the power production and RE plans on all RE sources. There must be laid down policies to attract foreign and domestic investors. Due to erratic power failure in Nigeria, the public awareness of RE is fast growing and renewable are being utilized for domestic applications such as solar electricity installation in homes and hotels and solar powering of street lightning. Though, solar PV has been applied for street lighting in some part of Cameroon, poor maintenance has crippled the process. In order to sustain the RE progress, there is serious need for the government of Nigeria and Cameroon to train local manpower in renewable and create entrepreneurship funding for locals who are interested in venturing into this sector. In the final note, it is fair to say that Nigeria is ready for RE implementation while Cameroon is seriously lagging behind in both RE policy and implementation.

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