PARADIGMS FOR SUSTAINABLE AND CLEAN ENERGY ACCESSIBILITY FOR SUB-SAHARAN AFRICA

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Abstract

Nigeria and virtually all countries in Sub-Saharan Africa (SSA) are energy poor. Whereas part of the solutions exists in form of a number Renewable Energy Companies (RECs) bringing in different RE schemes for sustainable and clean energy; many individuals in these countries are oblivious of the solutions within their reach. In this paper an in-depth review of key actors in the Renewable Energy Landscape (REL) in Nigeria and Africa shall be presented. It analyses their mode of operation, method of financing, degree of impact, sustainability practices etc. This paper would serve as an advisory for any individuals or organizations willing to become participants in the RE Market (REM) in SSA. It would also serve as background information to individuals, communities, government/government agencies, NGOs, CBOs, philanthropists and investors on available sustainable energy solutions.

INTRODUCTION

In the year 2030, it is expected that all UN member states achieve sustainable energy for all in accordance to Goal 7 of the Sustainable Development Goals (SDGs) put up by the United Nations General Assembly in September 2015 [1]. This SDGs took over from the initial goals tagged Millennium Development Goals (MDGs); which ran its course from September 2000 to 2015. Sub-Saharan Africa failed miserably to meet with most of the goals listed in the MDGs [1]. Even though many scholars concede that the goals were designed out of favor with Africa [2] [3] [4] and stated that failure based on the criteria used by the governing bodies was inevitable, it is important nonetheless for Africa to plan accordingly in order to meet up the requirements of the SDGs by the year 2030.

In this paper, we shall focus on the issues relating to the 7th SDG goal – Affordable and Clean Energy. We shall analyze the readiness of some nations in SSA to meet the goal in the year 2030 and also some international, government and private initiatives that have sprung up in these years.

The review of literature reveals that Renewable Energy provision and increased access in SSA have been largely due to three (3) key participants namely International agencies, Government and Government agencies of the nations of Africa and Private participants [5].

In Nigeria, we see a transition in the Energy sector; the Federal Government of Nigeria (FGN) established the National Electrical Power Authority (NEPA) in 1972 and NEPA ran as a single entity. In 1998, the FGN amended the Electricity acts in a bid to remove the monopoly enjoyed by NEPA and also to involve the Private sector. The plan to involve the private sector eventually came in the Electricity Power Sector Reform Act in 2005. Before then, the Federal Government has been solely responsible for the formulation of Energy policies, regulation, operation and investment. The Electricity Power Sector Reform Act was set up to enable companies take over the activities (power generation, transmission and distribution) of the then National Electrical Power Authority (NEPA) in order to reduce the monopoly in the Power sector.

One major issue leading to poor electrification in SSA is the inability of major stakeholders in energy provision in these countries to provide harmonious energy policies as seen in [6]. Other energy stakeholders have endeavored to develop policies that could be implemented within their countries and failed to receive the appropriate backing from their Government like the Strategic National Energy Plan, 2006 (SNEP) and the Energy for Poverty Reduction Action Plan (EPRAP) developed in Ghana [6].

METHODS FOR INCREASING ENERGY ACCESS IN SSA

Rural Electrification using Renewable Energy and Renewable Energy Technologies

By Including more renewables into the energy mix, access to Energy in Africa especially to rural communities would increase. The IEA reports that at least 60 percent of the new generation would have to come from Renewables in order to achieve universal sustainable energy by 2030 [7] [8]. Rural communities have experienced low electrification levels. Some of the reasons for low electrification in Rural communities include high capital costs associated with grid extensions, difficult terrains, some households may not be able to afford the cost of electrification etc. [9] . These solutions could come in the form of pico lighting systems which could be in the form of solar lanterns with charging points for mobile phones [10], micro or mini-grids, and stand-alone systems. Table 1 shows electrification level in Sub-Saharan Africa The market for solar lighting products and small solar home units have been on the increase since 2012, an estimated $ 31 billion exists for the solar lights and solar home systems [10]. More awareness need to be undertaken to rural communities on these energy solutions.

Some countries in SSA have demonstrated initiatives in the drive to increase energy access. For instance, Senegal with Isofoton from Spain serviced 5000 households with nine hybrid power plants in the remote areas of Saloum Delta [11]. Mali has also made significant strides in the implementation of hybrid mini-grid systems in 2011, a 216 kWp PV/diesel hybrid was installed, this was a collaboration between the national utility and funding from the Malian Bank for Commerce and Industry. Some other projects in Mali are being sponsored by the World bank, African Development Bank, the Rural Electrification Agency (AMADER). The Rural Electrification Agency of Tanzania currently supports the activities of private developers as they develop hybrid systems. The hybrid systems developed are mostly within the range of 1 to 10 kWp. Mauritania has also received funding from the European Union and with that was able to implement six hybrid PV/diesel power plants across the country.

TABLE 1: **ACCESS TO ELECTRICITY RATES IN SUB-SAHARAN AFRICA (% OF TOTAL, % OF URBAN POPULATION, % OF RURAL POPULATION)**

S/N	COUNTRIES	ACCESS TO ELECTRICITY (% OF POPULATION)	ACCESS TO ELECTRICITY (% OF URBAN POPULATION)	ACCESS TO ELECTRICITY (% OF RURAL POPULATION)
1	Angola	37.00	83.00	6.00
2	Burundi	6.50	58.50	1.20
3	Benin	38.40	68.00	14.50
4	Burkina Faso	13.10	48.50	1.40
5	Botswana	53.24	71.05	23.87
6	Central African Republic	10.80	14.88	8.15
7	Cote d'Ivoire	55.80	88.10	29.00
8	Cameroon	53.70	87.50	18.50
9	Congo, Rep.	41.60	58.90	11.70
10	Comoros	69.30	85.10	61.40
11	Cabo Verde	70.56	84.35	46.75
12	Eritrea	36.08	100.00	11.95
13	Ethiopia	26.56	100.00	7.55
14	Gabon	89.30	98.10	44.90
15	Ghana	64.06	84.95	40.95
16	Guinea	26.20	74.20	2.90
17	Gambia, The	34.53	41.01	25.65
18	Guinea-Bissau	60.61	100.00	21.45
19	Equatorial Guinea	66.00	93.10	43.00
20	Kenya	23.00	58.20	6.70
21	Liberia	9.80	18.91	1.20
22	Lesotho	20.56	46.93	10.15
23	Madagascar	15.40	60.70	8.10
24	Mali	25.60	50.41	11.90
25	Mozambique	20.20	54.50	5.40
26	Mauritania	21.76	46.01	4.35
27	Mauritius	100.00	100.00	100.00
28	Malawi	9.80	37.10	2.00
29	Namibia	47.26	94.11	17.35
30	Niger	14.40	61.80	5.20
31	Nigeria	55.60	83.60	34.40
32	Rwanda	18.00	61.50	7.70
33	Sudan	32.56	62.11	17.75
34	Senegal	56.50	87.80	26.60
35	Sierra Leone	14.20	46.50	1.20
36	Somalia	32.71	57.67	17.25

37	South Sudan	5.06	12.27	3.45
38	Sao Tome and Principe	60.46	68.29	46.95
39	Swaziland	42.00	100.00	24.45
40	Seychelles	100.00	100.00	17.25
41	Chad	6.40	18.32	3.05
42	Togo	31.46	67.57	8.85
43	Tanzania	15.30	46.40	3.60
44	Uganda	18.16	71.23	8.05
45	South Africa	85.40	96.56	66.85
46	Congo, Dem. Rep.	16.40	36.32	5.75
47	Zambia	22.06	46.93	5.75
48	Zimbabwe	40.46	78.46	16.05

Private Party Participation and Investments

According to [12] and [13], failed Publicly funded Renewable Energy projects in Africa have the following in common causes: prolonged durations, substantial budgets, multiple stakeholders and apprehension, lack of implementation and effective management. In the face of these challenges, one would expect that Public-Private Partnership (PPP) renewable energy projects would fare better because they have a private component to them, however, private organizations in PPP projects have been known to inflate developmental cost so that they can acquire the Return on Investment (ROI) even before the commencement of the project [12].

Looking ahead of the Sustainable Development Goals enacted in 2015 and the Paris agreement at COP21, one would agree that private investment plays an important role in its fulfilment [14]. There has been an increase in the investment in renewable energy so much so that in 2015, the investment in renewable energy in developing countries surpassed that of developed countries for the first time; figure 1 shows the details.

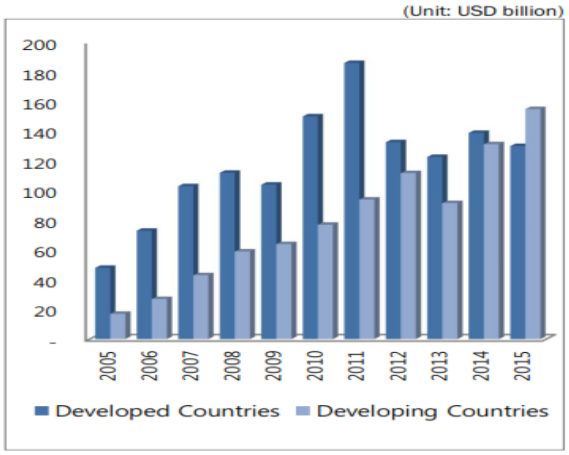

Figure 1: New Renewable Energy Investment (2005-2015)

Source: World Economic Updates (2016), Frankfurt School-UNEP Centre/BNEF (2013,2014,2015). Global Trends in Renewable Energy Investment 2014,2015, and 2016.

Having viable renewable energy deposits alone is not sufficient enough for the development of Renewable Energy in any country; properly structured institutions, market readiness, regulations are also required [14].

A review of literature show that there are four major risks associated with renewable energy projects. These perceived risks could prevent investments in Renewable energy activities. They are financial risks, governance risks, project management risks and public opposition risks. Of these four; Private party investments can tackle financial and project management risks. Financial risks deal with risks associated with return on investment and other potential financial losses; while Project management risks include all risks associated with human capital, technology, construction and management [15].

Initiatives like the United Nations Environment Programme (UNEP) Seed Capital Assistance Facility (SCAF); which helps to provide early-stage financing (usually about 1 to 5% of the total finance) for project managers, Scaling-up Renewable Energy Program (SREP); which helps to carry out feasibility analysis in developing countries to reduce the risks of private participants engaging in non-viable renewable energy projects have helped to reduce financial and project management risks faced by private participants.

Pilot projects: Stories from selected counties in SSA

Countries like Mexico, Argentina, Chile, Brazil in Latin Asia and Indonesia, Cambodia, Bangladesh, China, Nepal, India, and Sri Lanka in developing Asia have recorded immense successes in rural pilot schemes [16] [17] [18] [19]. SSA has not been so fortunate in this feat, as series of failed projects have lined up the landscape. In Nigeria for instance, there is a record of at least 12 trillion Nigerian Naira worth of failed projects [20], the failure of these project can be associate with lack of proper policy planning and political will [21] [22]. Some of the reasons why projects fail in SSA are lack of technical skills and expertise needed to manage the systems, non-availability of spare parts, inappropriate financing structure, lack of managerial and operational structuring post-commissioning [23]**.** Regardless of the failures, international institutions like the World Bank, the United Nations Development Program (UNDP), Global Environment Facility

(GEF), European Union, Governments e.g. German Government, Spanish Government continue to support rural electrification programs in developing countries [24].

Namibia

One of the successful pilot projects in SSA is in Namibia, precisely in Tsumkwe village in the North-Eastern part of Namibia. The hybrid solar-diesel mini-grid was designed and it has been operational since its completion in 2012. The budget for the implementation of the project US$ 3 million was funded by the European Union based on a feasibility analysis carried out by the Desert Research Foundation of Namibia (DFRN) working with the European Commission (EC), NamPower and the Otjozondjupa Regional Council (OTRC). This bybrid system is made up of 202 kWp, 918 polycrystalline solar panels, lead acid deep cycle batteries 766 KWh in capacity, two sets of generators rates 150 kVA each and one standby 350 kVA diesel generator. Part of the reasons why the Namibian project was successes is the tariff differences for different consumers, residential consumers pay US$0.15/kWh while commercial and public institutions pay US$0.25/kWh (2015 figures). The project has been highly beneficial to the members of the community they have recorded heightened security levels especially at night time, students can now read for longer periods; this has led to increase in the performance, increase in economic productivity, increase in the standard of living [23].

Rwanda

The Ministry of Infrastructure (MININFRA) and the Netherland Development Organization (SNV) conducted a feasibility study in 2005 to access the viability of a National Domestic Biogas Programme (NDBP) in Rwanda. The overall objective of the program was "to establish a sustainable and commercial domestic biogas sector in Rwanda" [25]. This objective was carried out by promoting the use of family-sized anaerobic (biogas) digesters on a large scale [26]. In 2001 at least twenty-eight biogas digesters were installed while eight were under construction [27] by 2013 at least 300 bio digesters had been installed [28]. After an evaluation subcontracted to the Rheinisch-Westfalisches Institut fur Wirtschaftsforschung (RWI) and the International Institute of Social Studies (ISS) by the Policy and operations Evaluation Department (IOB) and the SNV in 2013; it was discovered that access to biogas resulted into increased energy savings and reduction in the use of traditional fuels. Also, 80% of the users received training, 42 companies specializing in biogas commenced operations and the Banque Populair Rwanda provides loans for the acquiring of digesters to interested parties [28].

Tanzania

Tanzania's Traditional Energy Development and Environment Organization (TaTEDO) in conjunction with the United Nations Settlement Program of UN-HABITAT implemented a 200m^3 biogas plant in Manzese Secondary school, Tanzania. The program began in May 2014 and was completed in June 2015. Teachers, students and other stakeholders were educated on the part of the system and how to use the system effectively. Also, a training manual written in Swahili was distributed [29]. Other activities undertaken by TaTEDO to increase energy access includes 100 villages (~ 37,000 people) receiving access to energy through Mini-grids and Solar PV systems in collaboration with the European Union [30], in partnership with the Energy and Environment Partnership Programme (EEP), TaTEDO implemented a project with the aim of increasing energy access in social and business centers located in off-grid areas [31].

Kenya

In [32], it was reported that the Government of Kenya estimated that there are 20,000 PV home systems currently in use in Kenya. The systems account for 9 Gigawatt-hours (GWh) of electricity generated annually. With financing from the French Development Agency and European Union in 2010; $16 million was set aside for the building of a 5 Mega Watts small hydropower power for four (4) tea processing plants in Gura, Kenya [33]. Green Energy Africa, a company in Kenya launched a project between September 2014 and March 2015, they were able to distribute 400 Solar lanterns in Makueni and Kajiado counties of Kenya and provided about 30,000 households with information on solar energy, renewable energy and entrepreneurship [34].

Ghana

The Energy Commission in Ghana and the Ministry of Science and Technology in China funded by the Danish Government in 2014 launched a project with the aim of transferring Renewable Energy Technology, the project also aims at "developing an institutional framework and capacity for the absorption of the technologies" [35]. Yam Pro Energy, an Israeli-based company is partnering with the Ghanaian Government to build and set-up a Wave-Energy Plant (WEP) on the coastline of Accra. The project which will begin in 2017 is expected to benefit at least 10,000 households [36].

Seychelles

Although Seychelles currently has 100% electrification through a grid based system and diesel generators installed at different parts of the Island, plans are underway to increase the Renewable Energy mix by 5% in 2020 and 15% in 2030. In the Island of Mahe; the main Island in Seychelles, as at 2014 there was a 71 MW installed diesel capacity for a population of 80,000 people with a peak load of 50 MW and in Praslin/La Digue there is an installed diesel capacity of 13 MW for a population of 8,500 people with a peak load of 7 MW. These figures are expected to rise to accommodate for the increasing load in the next fifteen years. The Renewable Energy potentials of the Island has been analyzed and reported by [37], based on the report; wind exploitation in Seychelles is not the favored option because of the mountainous terrain. However, there is enough biomass that can be extracted from the plant species found on the Island to last 15 years. Also, in 2014 about 400 KW of Photovoltaic panels that were installed on the Island.

Nigeria

2015 and 2016 were vibrant years in Renewable Energy project commissioning in Nigeria. Several private companies like GOSolar that has installed a 70 KW hybrid plant in Irewekun South West Nigeria and another in Computer Village in Otigba in 2015 with a size of 15KW [38]. Rubitec Solar proposed a Solar Hybrid Mini-Grid in Gbamu Gbamu, Ogun State. The project was broken into two phases; the first and second phases are 62.4KW systems, the system accommodates for 292 residential homes, 116 productive and 32 institutional buildings [39].

RESULTS OF RURAL ELECTRIFICATION

Increases Quality of life

According to Alstone et al [40], there is a strong relationship between access to energy and Human Development Index (HDI). Human development Index which refers to longevity, knowledge and GDP can be used to provide useful information about a country's current level of development [41]. Energy is a vital but not an all-encompassing part of human development [42] [10]. According to [43], access to electricity ensures increased access to media thus increasing awareness of health-related challenges, increased awareness leads to change in health behavior.

Increases Quality of Education

Increased electrification in rural communities helps to improve the quality of education in these areas. Students are taught with modern teaching and learning tools, thus helping to increase their prospects in furthering their education or employment [44]. A study in Philippines show that electricity increases study time at least by one hour in the evening [45]. Also, it was discovered that children in electrified household tend to have higher education levels when compared to those living in areas without electricity [43].

Poverty Alleviation

An increase in Energy could lead to an increase in Income. However, this premise is only valid when additional effort is made to channel the energy increase into productive entrepreneurial activity [9]. Productive uses of electricity would in the long run result in increase of income in the household level, this will also lead to the acquisition of more assets and savings and more employment possibilities [46].

Increased Environmental Protection

Adopting of clean renewable energy in rural communities leads to a reduction in the dependence of fuel wood and other forms of biomass. Also, clean energy from renewables would lead to lesser carbon emissions thus reducing the damage on the atmosphere.

Increase in Employment and Skill Acquisition

In [47], the effects of electrification were analyzed in South Africa based on the Governments' initiative that increased electricity to rural households. The result revealed that electrification increased female employment within five years. However, it was also discovered that male earners were increased and female wages were reduced as a result of the increase in electrification.

Increased Access to Adequate Health care and Health care facilities

Increased access to electricity leads to improved health care [48]. Medical personnel in rural communities would have access to better tools to preserve vaccines. Individuals residing in rural communities would be able to have access to better health care.

CONCLUSION

The paper reveals exploit in Renewable Energy in some Countries in Sub-Saharan Africa, we have been able to see the adoption and acceptance of Renewable energy and allied technologies in Africa. Some key stakeholders in the renewable energy landscape and their involvement have been highlighted. Conclusively, some benefits of adopting Renewable Energy have also being highlighted.

Several opportunities still abound in the energy provision landscape in SSA. From the Provision of Renewable Energy Power Generation Infrastructure; Installation, Manufacture, Sales and Maintenance of Metering Infrastructure; IT Infrastructure; Capacity Building (training of workforce; procurement, acceptance, installation, measurement and verification, audit management etc.)

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