

RENEWABLE ENERGY INTEGRATION, A CATALYST FOR INDUSTRIALIZATION AND LIVELIHOOD IMPROVEMENT IN SUB- SAHARAN AFRICA

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ABSTRACT

Africa is growing rapidly in population, towns are becoming cities, the quest for reliable energy supply is on the rise. This energy is needed for economic development, industrial production, enhancement of research-based work in tertiary institutions, light to areas where access to electricity is scarce and provision of jobs for the unemployed. High demand for affordable and a reliable source of energy to meet the present energy need in sub-Saharan Africa has proven that oil, coal and natural gas as are insufficient. Sufficient energy needs are required through renewable energy integration. The aim of this article is to qualitatively analyze the importance of renewable energy integration to the existing grid, serving as a catalyst for industrialization and livelihood improvement in sub-Saharan Africa. Secondary data from the International Energy Agency report indicating the energy

Introduction:

As the population of Africa grow rapidly and towns are becoming cities, the quest for reliable energy supply is on the rise. This energy is needed for economic development, industrial production (Ajayi *et al.*,2017), enhancement of research-based work in tertiary institutions, light to areas where access to electricity is scarce and provision of jobs for the unemployed (Tomala *et al.*,2021). In the year 2000, Africa's population was around 820 million, accounting for 13per cent of the world's 6.1billion people. In 2018, this population had doubled more than the global rate

profile of selected countries in Sub-Saharan Africa, showing the power generating source for each country representing each of the regions in sub-Saharan Africa. Democratic republic of Congo is the country with the lowest access to electricity (10%). Improving the energy sector plays an important role in ensuring access to electricity, increasing productive economic activities and increasing the country's export potentials. Lack of access to electricity is one of the key barriers to the development of Sub-Saharan Africa. Therefore, the region needs extensive efforts to develop the energy sector, both on the part of individual countries and the region as a whole.

and it may double in the next two decades. Africa's fastest growing population is made up of the youths and around 60 per cent of this population live in rural settlements, search for better and improved life is causing massive rural-urban migration leading to high population density in urban areas (IEA, 2019). The slow growth in the power sector if not tackle, will lead to more economic backwardness. Africa as a continent is endowed with a lot of natural resources among which are different types of renewable energy. Sub-Saharan Africa has approximately 950 million people immensely suffering from energy deficits. About 600 million people in the region have no access to electricity while some are connected to unreliable power source (Stephen, 2003). The annual electricity consumption per household in sub-Saharan Africa is 488 kilowatts hours per capita which is equivalent to about 5 per cent the consumption of the United States (Avila *et al.*, 2017). The living standards of larger population of people resident in sub-Saharan Africa are critically poor. Many homes lack clean cooking facilities, relying heavily on firewood, charcoal and animal dung with negative effects on their health (Sola *et al.*,2021). Sufficient energy delivery increases healthcare and food production, enhances living standards, improves industrial output, better education and research standard, clean and portable water, and efficient transportation (Somefun *et al.*,2020). Africa as a continent has only 50 gigawatts (GW) of renewable energy capacity and mostly from hydropower with 36GW (IEA, 2019). Between 2010 and 2018, 40 percent

of the world's gas discoveries were in Africa which offers the continent with a new industrial development. Between 2010 and 2018, Africa has an installed generation capacity of 155gigawatts (GW) to almost 245gigawatts, South Africa and North Africa account for 165gigawatts of this installed capacity (IEA, 2019). South Africa accounts for 45% of total electricity generated in Africa, while North Africa accounts for 30%. This effectively leaves Sub Saharan Africa (where 80% of the continent's population resides) with only 24% of total electricity generated in Africa.

Table 1: Share of Installed Electricity Capacity Per Region

Region	% share
South Africa	45
North Africa	31
Other Africa countries	24

Source: Karekezi and Kithyoma, 2003

Renewable energy is energy derived from natural source that is replenish within a short time after usage or consumption (Shiva, 2017). These natural sources include hydropower, wind, solar energy, Biomass, Ocean energy, Geothermal and Waste to energy. Sub-Saharan Africa is home to these great renewable energy sources, which has remained untapped (AFDB, 2016). Africa as a continent consumes more of oil (42%), gas (28%), coal (22%), hydro (6%), renewable energy (1%) and nuclear (1%). With the current fall and rise in oil prices in the world market, depletion in oil reserved and to cut down in carbon emission, the need for embracing the renewable energy cannot be over emphasized (AFDB, 2016). Africa has the potential of generating 10 gigawatts (Gw) from hydro, wind and geothermal. Between 2010 and 2018, renewable energy capacity has increased from 28 GW to 50 GW. Hydropower takes the lead as its capacity had increased from 28GW to 35GW between 2010 and 2018 (IEA, 2019). Improved power generation can increase the continents manufacturing sector, create more jobs, improve quality of life and living standards for Africans (Rao and Pachauri, 2017). One of the reasons for embracing new

technology of renewable energy is to achieve total electrification of the region by 2030 and to keep to the Paris agreement signed Under the Paris Agreement, where 45 African countries have included targets for an activities to support renewable energy expansion in their Nationally Determined Contributions (NDCs) (RETA, 2021) in 2015 (Renewables, 2020). Countries in sub- Saharan Africa like, Senegal, Egypt, South Africa and Kenya – are demonstrating encouraging trends in terms of adding new renewable energy capacity. Southern Africa is taking lead in the continent in terms of installed renewable capacity, with 19,000 MW. However, Central Africa (e.g. Cameroon) has the highest share of renewables installed with 72 per cent, mainly from hydropower (RETA, 2021). Research have shown that the cost of electricity in sub-Saharan Africa is three times costly than in other developing countries of the world (Azolibe and Okonkwo, 2020). Countries in the sub-Saharan Africa need to invest more in the provision of affordable and sustainable energy through the integration of renewable energy, boost the manufacturing sector to build a stronger economy, achieving Africa of our dream.

Literature Review

The quest for affordable and a reliable source of energy to meet the present energy need and growing population in sub-Saharan Africa has proven that oil, coal and natural gas as energy sources is insufficient (Ellaban *et al.*,2014). Sufficient energy need is required through renewable energy integration. Energy sources which are derived from natural sources and are replaced or re-grown immediately after consumption are referred to as renewable energy (Ellaban *et al.*, 2014). These renewable energy sources include the sunlight (solar energy), Wind, Water (Hydropower), Tides (Ocean energy), Geothermal heat. Biomass and Waste to energy (Gorjian, 2017). Africa as a continent need to utilize its abundant and untapped renewable energy sources to stimulate industrial growth, reduced poverty, improve healthcare, facilitate research in schools, improve livelihood and uplift the economy in general. Massive investment in these renewable energy technology calls for a concerted effort and a decisive decision on

the government. Energy integration is key to industrialization in sub-Saharan Africa (Renewable Energy Transition, 2021).

Energy integration is the inclusion of varieties of the renewable energy sources to the natural gas and other few non-renewable sources in order to meet the demand requirement of a clean, reliable and sustainable electricity generation (Kumar *et al.*, 2019). Many countries around the globe are making concerted effort at increasing the concentration of renewable energy integration, targeting 35% consumption by 2030. China is among the countries projecting to increased its renewable energy pool. India is targeting 175GW, the European union and the USA are pursuing same, and some countries are projecting 80% renewable energy integration by 2050(Kumar *et al.*, 2019). According to the United States Department of Energy (2019), “renewable energy integration is the incorporation of renewable energy, distribution, generation, energy storage, thermally activated technologies and demand response into the electric distribution and transmission system”. The sustainable development goal (SDG) has set target for improvement of basic human needs. One of the common targets is improving the living standards of people at home by providing access to electricity, clean cooking energy, improving water, sanitation and health care (Rao and Shonali, 2017). Research shows that improving of the energy sector plays an important role at ensuring access to electricity and stimulating economic growth, through the expansion of the economy and to increase productive economic activities and increasing the country’s export potentials (Tomala *et al.*,2021). Lack of access to electricity is one of the key barriers to the development of Sub-Saharan Africa. Therefore, the region needs extensive efforts to develop the energy sector, both on the part of individual countries and the region as a whole (Tomala *et al.*,2021). The development of the energy sector to driving a country’s economy and improving the standard of living of its citizens cannot be over emphasize. Part of the mission “Agenda 2063: The Africa We Want”, includes 30% increase in the efficiency of household energy consumption, and the implementation of an energy production policy that will enable higher productivity in rural areas

(Tomala *et al.*,2021). As the countries in the sub-Saharan Africa are making strategic efforts at achieving energy efficiency to boost industrialization and improve the standards of living, environmental issues and resilience to climate change must be given a priority. This calls for the integration of renewable energy.

The aim of this article is to qualitatively analyze the importance of renewable energy integration to the existing grid, as a catalyst for industrialization and livelihood improvement in sub-Saharan Africa. Secondary data will be used to present the energy profile of selected countries, representing the regions in the sub-Saharan Africa. The improvement made in integrating renewable energy in the selected countries and planned projections on industrialization and improvement in standard of living will also be presented. And the importance of the integration of renewable energy will highlighted.

Data and Methods

Data from the International Energy Agency (IEA) 2019 report indicating the energy profile of selected countries in Sub-Saharan Africa, showing the power generating source for each country representing each of the regions in sub-Saharan Africa, excluding Northern Africa.

Table 2: Energy Profile of Selected Countries in Sub- Saharan Africa.

Country	Electricity access (%)	Major power generating source
Angola	44	Hydro, Oil
DR Congo	10	Minigrit
Ethiopia	45	Hydropower
Ghana	84	Hydropower, gas (30%), oil (23%)
Kenya	75	Geothermal
Mozambique	30	Hydropower
Nigeria	50	Gas, Oil, Hydropower
Senegal	70	Gas

South Africa	85	Coal, gas, Oil
Tanzania	37	Hydro, Gas, Oil

Source: IEA (2019)

Improvement Made in Integrating Renewable Energy in The Selected Countries

Angola as one of the countries in sub-Saharan Africa rely majorly on oil and hydropower for energy generation. The country in 2019 generated 12,781GWh from hydropower- marine, 18GWh from solar and 200GWh from Bioenergy. While in the year 2020, it generated about 3794MW from hydropower (372MW), 13MW from Solar and 51MW from Bioenergy. The country is targeting to add 6540MW from renewable energy, majorly from hydropower by 2030. Angola as a country want to tap from the pool of the untapped renewable energy by depending less on oil and natural gas for electrification and achieve middle income status by 2022(IREA,2021). The economy will grow and standard of living will also improve if these plans are vigorously pursuit.

In Democratic republic of Congo, hydropower has dominated electricity generation. The Inga dams I and II which was commission in 1974 and 1982 generates 350MW and 1400MW. Cycles of crises has deterred the development of renewable energy in DR Congo. The recent projection of the energy generation is 44000MW from hydropower plans and 10MWp from solar PV to be installed (World Bank, 2020). This targets if achieved will increase electricity access, reduce poverty and increase income generation. The country has the lowest electricity access in the continent (IEA, 2019).

In Ethiopia, 44% of the citizens obtain their power from the grid while 11% obtain from power from Stand- Alone -Solar (SAS). The government has set up plans to ensure electrification of Ethiopia by the inclusion of more renewable energy (Hydropower,45GW, Wind,10GW and geothermal, 5GW) targeting total electrification by 2030. In 2017, access to electricity was 56% and household connectivity is 25%, with lower consumption rate per capita of 100Kwh. Presently, Ethiopia's total 4.5 GW energy comprises

3.8GW hydropower, 324MW wind power, 7.5MW geothermal and 317 MW biomass and others (Ashebir *et al.*, 2020). Plans are on the way to strengthen the country's energy sector of renewable energy (Energy Africa- Ethiopia,2021).

Even though 85% of Ghanaian population are connected to electricity, majority of the energy generation come from fossil fuel. With the exception of hydropower, Ghana intent to achieve 10% additional electrification from other renewable energy technology by 2030 (Ephraim *et al.*,2021). The renewable energy abundant in Ghana includes hydropower, solar, wind, tidal energy, biomass and waste – energy (Bernard, 2020). Integration of these renewable energy technology can boost the economy of Ghana, increase local income and strengthen the manufacturing sector (Ephraim *et al.*, 2021).

Kenya has a renewable energy capacity of 38% (Geothermal), 38% (Hydro/marine), 5% (Solar), 15%(wind) and 4%(Bioenergy). These renewable energies generate a total of 2191MW, while non-renewable generates 807MW and industry consumes only about 7% (IREA, 2021). Mozambique has the capacity of achieving 23GW electricity from renewable energy sources if properly harnessed. Most of these renewable sources has remains untapped (Luis *et al.*, 2021).

Nigeria has abundant solar, wind, hydropower and biomass with the capacity of generating about 1182.4GWh of energy per day. The installed plants of 12,522MW from the on-grid plant is only able to deliver 3775MW to the country. An estimated 937TWh per year or 93% of Africa's economically viable hydropower potential remains unexploited, much of which are located in Nigeria, Gabon, Madagascar, Angola, Cameroun, Ethiopia and Democratic Republic of Congo (Dodo *et al.*,2020). Nigeria has witnessed some improvement in the power sector which include the establishment of 200MWh solar photovoltaic farm in Ashama village in Delta state, the largest in west Africa. This project is expected to provide electricity to about 36% of the rural dwellers in the state, to reduce the impact of carbon emission generated by burning of fossil fuel from private own minigeneration and solid woods (Chibuzor *et al.*,2021). The world

Bank and the African Development Bank had also established a 100KW Adebayo solar hybrid mini grid in Edo state and Haverhill, Budo Oyo state. These mini grids are built with battery storage facilities to store much energy. these power plants also supplement Government efforts in rural electrification. About 500 household and 50 businesses are expected to benefit from this project. The investment is expected to boost business in rural areas, serve health centers and institutions of learning with the aim of meeting government projection of vision 30:30:30, that is delivering 30gigawatts of electricity, with 30 renewable energy by 2030 (Chibuzor et al.,2021). Unsteady power supply is causing Nigeria about 26.2 billion dollars. Nigeria is ranked 171 out of 190 countries in the world in getting electricity, indicating a serious energy deficit especially in sub-Saharan Africa (World Bank Report,2020)

South Africa has the largest electricity coverage in Africa with solar pv accounting for 3.8GW and wind power of 2.5 GW. Plans are on the way to expand renewable energy to 30GW. South Africa ranks the first in Sub-Saharan Africa with most of its electricity coverage obtained from renewable energy (REN, 2021). Tanzania drives most of its electricity energy from hydropower(2544GW), Solar (46GW) and Bioenergy (149 GW).

There is a relationship between access to electricity and industrial growth, which means industries can only function well when there is sustained, affordable and efficient access t electricity. Small Micro and Medium enterprises (SMME's) can grow efficiently when there is functioning electricity supply. Industrialization and manufacturing are the main driver of the economy of developed nations. Most of these industries are driven by adequate electricity supply through energy integration (Benedict *et al.*, 2019). Industrial high operating cost result from unreliable power supply. A country's industrial electricity consumption is a reflection of its economic growth (Eric *et al.*,2018). Per capita electricity consumption of any country reveals to some extend the citizen's standard of living. Developed countries like USA has an electricity consumption per capita of 12,947KWh, 10,218KWh (Australia), 7,138KWh (Germany) and 7,753KWh

(Japan). While developing countries like Bangladesh has an electricity consumption per capita of 280KWh, Cambodia ,206KWh, Nigeria ,155KWh and Myanmar, 152KWh (Christie *et al.*,2015). Most developed countries have invested and are still investing in renewable energy technology because of environmental issues and depletion of fossil fuel. For instance, china is targeting 35% of its consumption from renewable energy by 2030 (Kumar *et al.*, 2019).

Highlight of The Importance of Renewable Energy Integration

- ❖ Supports reduction in oil used,
- ❖ Achievement of larger area of electrification,
- ❖ Brings growth in health sector,
- ❖ Stimulation of industrial growth,
- ❖ Creation of jobs through the revamping of moribund industries and marketing of renewable technology products,
- ❖ Brings growth in educational sector
- ❖ Lowering the cost of electricity and achieving energy efficiency,
- ❖ Reduction in carbon emission and use of clean energy sources,
- ❖ Rural development
- ❖ Prevention of biodiversity loss,
- ❖ Reduced import dependency, etc.

Conclusion

The place of efficient electricity supply and distribution in the growth in industrialization cannot be over emphasize. Improvement in the livelihood of citizens depends on the quantity of energy supplied. Both government and private individual need to invest more in renewable energy technology to achieve larger coverage of electrification.

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