



## Systematic Review

### Renewable Energy Policies in Ghana

Mohammed Takase<sup>1\*</sup>, Rogers Kipkoech<sup>1#</sup>, Joy Kibet<sup>2</sup>, Faith Mugah<sup>2</sup>, Seth Yao Ahiabor<sup>3</sup>, Richard Kwadzo Asare<sup>4</sup>

<sup>1</sup>Department of Environmental Science, School of Biological Sciences, College of Agriculture and Natural Sciences, University of Cape Coast, Cape Coast, Ghana

<sup>2</sup>Department of Spatial and Environmental Planning, School of Architecture and Built Environment, Kenyatta University, Kenya

<sup>3</sup>Fred N. Binka School of Public Health, University of Health and Allied Sciences, PMB 31. Hohoe campus, Ghana

<sup>4</sup>Ho Technical University, Ho, Ghana

<sup>#</sup>Both authors contributed equally to this manuscript.

\*Correspondence to: Mohammed Takase, PhD, Department of Environmental Science, School of Biological Sciences, College of Agriculture and Natural Sciences, University of Cape Coast, Cape Coast CC000-CC525, Ghana; Email: [mohammed.takase@ucc.edu.gh](mailto:mohammed.takase@ucc.edu.gh)

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#### Abstract

**Objective:** Renewable energy policy is a framework used by governments or institutions to address problems related to renewable energy production, distribution, and consumption. The aim of this review is to explore into the goals, instruments and planned measures of the Government of Ghana in the renewable energy resources field.

**Methods:** Methodologically, the review focused and based its findings on the overview and analysis of laws and regulations and other official documents used by Ghanaian Government. Rapid review method was used in evaluation of what is already known concerning the policy and assessing critically current researches through systematic review methods.

**Results:** The results of the study revealed that progress has been made in renewable energy resources sector recently. The midterm targets for the proportion of renewable energy out of the overall energy consumption has been defined; input tariff have been adopted; legislative and socio-economic barriers of increased exploitation for renewable energy resources have been analysed and measures and activities suggested for effective resolution. The outcome of the review revealed that existing renewable energy resources related legislation is imprecise and incomplete. Several bylaws, standards and guidelines are still outstanding. The key renewable energy related documents are also inconsistent, lack clarity and are inaccurately decisive when implementing specific measures of incentives for the production of renewable

energy in Ghana. Furthermore, ineffective government policies have increased greenhouse gas emissions from fossil fuel combustion.

**Conclusion:** Investors therefore, have lost confidence in the government's ability to maintain and achieve current and future renewable energy policy targets, resulting in a reduction in investment in renewable energy projects. The massive transition of Ghana's energy sector to low-carbon technologies over the next 10 to 20 years is also a challenge.

**Keywords:** energy, Ghana, renewable, policy

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## 1 INTRODUCTION

Renewable energy policy is a policy approach which governments or organizations use to address renewable energy production, distribution, and consumption issues. Every renewable energy policy prioritises much on supply, security, cost and environmental implications. According to National Energy Policy, renewable energy policy should be cost-effective, reliable, and environmentally sound. The policy must also account for the influences of human behaviour and energy systems. Typically, Government of Ghana has developed and implemented renewable energy and energy efficiency (REEE) technologies policies in 2020 to achieve a 10% penetration rate in energy production and 100% national electrification to reduce the emission of greenhouse gases (GHGs)<sup>[1,2]</sup>. Despite the massive deployment of low carbon technologies, there is a continuous increase in the emission of GHGs and lack of legal and regulatory simplicity in accomplishing the renewable energy policy objectives and institutional independence<sup>[3-5]</sup>. In addition, inefficient government policies have resulted in the rise of GHGs emissions from fossil fuel combustion. As a result, investors have lost faith in the government's ability to maintain and achieve existing and future renewable energy policy targets, leading to underinvestment in renewable energy projects<sup>[1,6-8]</sup>. According to Gboney<sup>[9]</sup>, the massive shifting of the energy sector to low-carbon technologies in 10 to 20 years in Ghana is also a challenge among the developed and the least developed countries.

Ghana has abundant renewable energy resources such as biomass, wind, solar, and hydropower<sup>[5,8,10-12]</sup>. The country is among the initial United Nations' (UN) members in embracing the initiative dubbed "Sustainable Energy for All" (SE4ALL) that the UN put forward. SE4ALL Country's Action Plan has been developed to address three objectives; i) ensuring global access to modern energy services; ii) increasing the improvement in energy efficiency rate by double; and iii) doubling the share of renewable energy within the global

energy mix<sup>[2,6]</sup>. Global energy generation has replaced conventional fossil fuels to pollution-free energy that can be generated through renewable energy sources<sup>[13]</sup>. For example, Denmark generates more than half of its electricity from solar and wind. In 2017, Costa Rica's generated their electricity from renewable energy sources for 300 days. In the past years, countries such as Germany, Portugal and Denmark have been using renewable energy sources. Many countries are shifting to renewable energy sources because of lack of oil and gas reserves and they also want to be less dependent on import of energy<sup>[14]</sup>. Ghana employed renewable energy sources to generate electricity and other energy products. As a result, renewable energy has evolved from "alternative energy sources" to "competitive energy sources"<sup>[1]</sup>. This has made renewable energy becoming a viable source of a long-term energy for Ghanaians' economic, social and environmental needs<sup>[7,13-15]</sup>. The security of energy supply and global climate change has compelled renewable energy policies to be ranked the top of political agendas<sup>[7,16-18]</sup>.

Ghana expanded its access to electricity by more than 70% in the past five years, though statistics show that rural areas are lagging<sup>[8,19-21]</sup>. Mahama et al.<sup>[8]</sup> and Bonan<sup>[22]</sup> asserted that adequate access to electricity among the non-urban communities would help develop rural areas and create business opportunities. It will also increase access to water and health services and lightning systems as well as connecting rural communities to urban centres via information technology. Not with standing, Asumadu-Sarkodie and Asantewaa Owusu<sup>[23]</sup>, noted the severe constraints concerning the connection of electricity to the rural areas to the national grid including geographical and financial constraints.

Ayerigah<sup>[11]</sup> believed Ghana must expand access to electricity among the rural communities using off-grid community-based electrification based on the increasing share of renewable energy and promoting the productive uses of it. According to Asumadu-Sarkodie

and Asantewaa-Owusu<sup>[23]</sup>, the Government of Ghana developed a project to support broader socio-economic and environmental objectives and reduce poverty. This project of expansion of the electricity was formulated to enable Ghana and China to share their experience and skills on technologies in renewable energy. The authors indicated that the project was to facilitate the exchange of expertise and technology in renewable energy between China and Ghana. The project also highlighted on building the institutional framework and capacity needed to reduce the absorption of technologies locally. This was collaborated by The Energy Commission in Ghana and Ministry of Science and Technology in China with the Country Offices of UNDP in Accra and Beijing.

During the implementation in the first year, the project focus was to establish the environment that would enable transfer, produce and regulate the application of renewable energy technologies in Ghana. The project began on an assignment of “Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana”. The project reviewed the past and the present policies and strategies on renewable energy in Ghana and consultation by the stakeholder in identifying the policy gaps and proposal of solutions in boosting the renewable energy sub-sector in Ghana. There was an expectation that the impacts of these projects would lead to the subsequent activities of the project<sup>[12,13,24]</sup>.

On the other hand, the Ghanaian government realised the need to change to renewable energy resources for the country’s electricity generation and supply. Energy Commission found several reasons to begin generating electricity from renewable resources. According to Heffron<sup>[25]</sup>, seven energy principles should be considered when characterising and establishing energy law. Thus, (a) national resource sovereignty principle; (b) energy justice principle; (c) rational, prudent and sustainable use of natural resources principle; (d) environmental protection, human health and climate change mitigation principle; (e) access to modern energy services principle; (f) energy security and reliability principle; and (g) resilience principle. The principle of energy law is based on fundamental reasons for adopting renewable energy law such as energy security, climate change, and environmental preservation<sup>[15,26,27]</sup>.

Ghana has implemented various REEE laws and programs to maintain energy supply security and diversity. The country still faces cyclical energy outages and persistent insufficient energy supply systems. Gyamfi et al.<sup>[28]</sup> opined that Ghana’s renewable energy law could only be effective when the aims, instruments and measures surrounding renewable energy meet the country’s energy demands. Nevertheless, many questions

have been raised on the dormancy of the renewable energy policy in Ghana. Likewise, many believe Ghanaian’s renewable energy policy is not working and therefore the purpose and basis of the policy have been questioned<sup>[17,29-31]</sup>.

The aim of this review is to give insight into goals, instruments and measures put in place by the Ghanaian Government in the field of the renewable energy based on an overview analysis of the laws and regulations. Among the areas of highlights in this review include; the purposes of Ghanaian Government Renewable Energy Law, the international obligations and strategic orientation of Ghana in the domain of renewable energy such as, present legal framework and incentives for the production and exploitation of renewable energy sources in Ghana which are; renewable energy sources related legislations, such as the National Energy Policy and the Ghana Shared Growth and Development Agenda (GSGDA). The review further highlights main institutions in renewable energy resources sector in Ghana, key energy stakeholders and, obstacles of increase usage of renewable energy in Ghana.

## 2 MATERIALS AND METHODS

### 2.1 Rapid Review

The rapid review evaluates what is already known about a policy or practice issue by searching for and critically assessing current research using systematic review methods. Rapid reviews were selected to boost the speed of analysis. In this case the rapid review was employed to collect secondary data and analyses it using repeatable analytical approaches. The method helped to synthesise the evidence and developed broad or narrow research questions and discovered as well synthesise data directly related to the systematic review. Research projects were evaluated critically and qualitative and quantitative data synthesised. This provided a comprehensive overview of current data relevant to the research subject<sup>[1,32,33]</sup>.

### 2.2 Data Search and Analysis

The researchers collected existing evidence (information from the Ministry of Energy and Energy Commission) on the subject. Then, the researchers searched using Scopus, Pubmed, Medline and Google Scholar. The relevance of the selection stage determined the validity of the literature review. Several inclusions and exclusion criteria were used. Thus, documents not written in English and unfinished papers and articles were omitted from the review. Duplicate publications and studies that did not provide important information regarding the research topic were also eliminated. Articles that had nothing to do with the keywords were also omitted. Then, researchers meticulously read through those articles to select articles that meet the

purpose of the study. Critical analysis of the papers was then done.

### 3 RESULTS

#### 3.1 The Purposes of Ghanaian Government Renewable Energy Law

Global population growth and related resource pressure usually lead to laws or policies enactment to respond to industrial transformation<sup>[18,33-35]</sup>. Governments worldwide develop procedures to control environmental, economic, social, political and energy crises. Henceforth, the government of Ghana enacted a renewable energy policy to ensure all energy demands in the country are met. Initially, Ghana only relied on hydroelectric power, with few watts<sup>[2]</sup>. The government planned to double the renewable energy share to ensure efficient production, use and mitigate climate change. According to the Ministry of Energy<sup>[19,36-38]</sup>, the renewable energy policy sought to provide sustainable energy consumption, improve production and promote its efficiency<sup>[18]</sup>. The policy also expresses the hope of ensuring the creation of an efficient energy market that will supply sufficient, viable and efficient energy services for Ghana's economic development<sup>[20,39-41]</sup>. Ministry of Energy<sup>[38]</sup> affirmed that Ghana's Renewable Energy Policy aims at accelerating the development and use of renewable energy and ensure efficient energy technologies. In addition to this, the government wanted to achieve 30% rural electrification with renewable energy technology by 2020.

The policy is designed to offer a legislative and regulatory framework for achieving renewable energy policy objectives<sup>[6,21,42,43]</sup>. Kuamoah<sup>[6]</sup> asserted that the Renewable Energy Act (Act 2011) establishes legislative and regulatory frameworks for achieving renewable energy targets. The Renewable Energy Act's (2011) overarching goal is to provide efficient and environmentally sustainable development, management and utilization of renewable energy resources to generate heat and power<sup>[44-46]</sup>. The policy was also to encourage the development and use of renewable energy resources and create a climate conducive to investment in renewable energy resources. The policy was as well to promote the use of renewable energy, diversify renewable energy supplies to provide energy security and enhance access to electricity<sup>[23,47-50]</sup>. Public education on renewable energy production and use is needed to establish indigenous capacity in renewable energy technology in order to fulfil the goals of other international bodies<sup>[21]</sup>.

#### 3.2 International Obligations and Strategic Orientation of Ghana in the Domain of Renewable Energy

Being a party to the UN Framework Convention on Climate Change (UNFCCC) and the COP 26, Ghana

expressed its commitment to fulfilling the Convention's obligation<sup>[24,51,52]</sup>. Ghana has put in place mitigation and adaptation measures in its Intended Nationally Determined Contribution (INDC) including mitigation and adaptation in the INDC in resonating with the medium-term agenda of development (Ghana Shared Growth Development Agenda II-GSGDA 2) and the expected 40-year socio-economic transformational plan and universal development goals<sup>[53,54]</sup>. There is an expectation on the implementation of the actions which will assist in attaining low carbon climate resilience by effective adaptation and lowering GHG emissions. The emission reduction's goal of Ghana is an unconditional lowering of its GHG emission by 15%<sup>[24,25,55-57]</sup>.

The renewable energy sector of Ghana's mirrors the wide regional setting whose definition is about the Economic Community of West African States (ECOWAS). Generally, ECOWAS communities have a low energy consumption rate because of a lack of access to modern renewable energy resources such as hydropower and biofuels. The development in the renewable energy sector among ECOWAS is however, crucial for the growth of economic activity and the eradication of poverty. As at 2010, ten of the 15 ECOWAS member nations including Benin, Gambia, Burkina Faso, Ivory Coast, Ghana, Togo, Senegal, Cape Verde, Nigeria, and Mali, had more than 20% access to electricity. The relatively, high access to electricity in Ghana was possible because of the success in implementing the country's National Electricity Scheme. On average, the access rate of electricity in the region was about 40% in 2011<sup>[26,58-60]</sup>. Several countries had less than 20%<sup>[27]</sup>. In most ECOWAS member states, access to electricity was limited to only about 5% of the population in rural areas. This is partially because of the little income supply infrastructure of electricity which is underdeveloped<sup>[26,27,61-63]</sup>.

ECOWAS has put in place some measures to promote renewable energy technologies and harmonise the legislation on national energy which will increase independent energy supply and massive improvement of access to modern energy services. The policy responds to the increasing security concern of energy, lack of access to energy and the importance of mitigating climate change. Achieving these goals requires several policy strategies and programmes developed in the regions of ECOWAS as follows: white paper on regional policy on energy service accessibility by the population in rural and semi-urban areas. It was expected to raise the accessibility to energy services and not less than 20% of the new investment in electricity generation using renewable resources<sup>[31,64-66]</sup>.

As of 2015, accessibility to electricity should have

been 100% to cater for the basic requirement of urban and peri-urban areas and 36% accessibility of the basic needs in households in rural areas as contained in the white paper. In addition, ECOWAS was hoping to achieve 100% accessibility of modern energy by 2015 whereby 50% to 70% was to be through Liquefied Petroleum Gas and the remainder through cookstoves using improved wood fuel<sup>[27]</sup>. The West African Power Pool has given a master plan that has been revised to create a regional market of electricity from the year 2020 to 2025. Classification of ECOWAS countries in the plan is as follows:

- (i) Potential self-sufficiency because of a large coal-fired thermal power plant after 2020. These countries include Niger, Ivory Coast, Nigeria, Senegal, Ghana and Togo/Benin.
- (ii) The expectation of remaining dependent on power imports from neighbouring countries until 2020. The countries were Gambia, Mali, Niger, Guinea-Bissau and Burkina Faso.
- (iii) Potential exporter of power after 2018 through the development of hydroelectricity. The countries in this category are Guinea, Liberia, Ivory Coast and Sierra Leone.

The electricity supply capacity in bulk was expected to be generated from big hydroelectric power plants and natural gas. Based on the master plan, it is envisaged that there will be an additional 16,000km of transmission lines and 10,000 megawatts (MW) of the installed capacity. Out of this, 7,000MW is expected to be obtained from hydropower sources by 2025. There is an addition of 10% of renewable energy excluding hydroelectricity to the region's electricity fuel mix. Interconnection project between Ghana and Togo with an output of 330 kilovolts was commissioned in late 2014<sup>[27,67-70]</sup>.

Energy ministers from ECOWAS states formed REEE in 2008 boost energy sufficiency. They received support from Austrian and Spanish Governments and UN Industrial Development Organisation were to offer technical support. In Praia in Cape Verde, REE was formed in 2010, and galvanising efforts were initiated in various member states of ECOWAS. Its goal was to integrate renewable energy into the energy policy of the ECOWAS member states. The formation of REE aided in the eventual expansion of the ECOWAS Renewable Energy Policy to a greater extent. In November 2012, ECOWAS member nations approved a policy with several objectives. Among the objectives is improving energy supply, ensuring safety and sustainability, reducing dependency on imported fossil fuel, and exposure to volatile hydrocarbon. Another objective was to promote rural and urban access to energy, creating a favourable environment for the investment by the private

sector, and employing the use of renewable energy in driving the growth of industrial and socio-economic development<sup>[27,28,71-73]</sup>.

## 4 DISCUSSIONS

### 4.1 Present Legal Framework and Incentives for the Production and Exploitation of Renewable Energy Sources in Ghana

#### 4.1.1 Renewable Energy Sources Related Legislation

The medium-term of present Ghana's national policy framework for the country's entire development is the GSGDA for 2014-2017. The major energy policy guiding the energy sector in Ghana is the National Energy Policy, and it gets support from Energy Sector Strategy and development plan. In addition, the renewable energy Act of 2011 was passed into law to provide the legal and regulatory framework needed for developing and expanding Ghana's sub-sector of renewable energy. Various sectors of the economy have also implemented policies having components on the development and utilisation of substitute energy specifically, renewable energy. In addition, Ghana came up with Country Action Plan for SE4ALL in 2012<sup>[29,39,74-76]</sup>.

#### 4.1.2 GSGDA

GSGDA outline power as the key constraint that binds constraint to accelerated growth and development of the economy<sup>[30,43,77,78]</sup>. GSGDA illustrates that "In the medium-term, Government policy will focus on increasing the proportion of renewable and other energy sources in the supply mix, particularly solar, wind, mini-hydro and waste-to-energy. The strategies to be implemented include the following:

- (i) Speeding up the implementation of the 87 provisions of the Renewable Energy Act 2011, Act 832;
- (ii) Provision of access to waste-to-energy technologies;
- (iii) Facilitation of access to the grid for stand-alone renewable energy power plant.

### 4.2 National Energy Policy/Energy Sector Strategy and Development Plan

The major policy guiding the development and management of energy sector in Ghana is the National Energy Policy 2010. The policy states that "the goal of the renewable energy sub-sector is to increase the proportion of renewable energy, particularly solar, wind, mini-hydro and waste-to-energy in the national energy supply mix and mitigate climate change"<sup>[19]</sup>. The energy sector's vision is outlined in the Energy Sector Strategy and Development Plan 2010. Hence, it seeks to guarantee the availability of an adequate level of energy supply to meet the country's internal demands and ensure universal access to modern energy by 2025 and provide surplus energy for export<sup>[19]</sup>. The major constraint in the energy sector to be tackled for the realisation of this

vision include:

- (i) Development of infrastructure for producing and supplying of sufficient energy service aimed at meeting the national obligation and for export;
- (ii) Expansion of the requisite infrastructure in ensuring universal access as well as the efficiency and reliability of supply of energy services;
- (iii) Ensuring energy production and supply in a form without adverse health, safety and environmental impact;
- (iv) Guarantee the efficient production, transportation and use of energy.

The Energy Sector Strategy and Development Plan outline that for solar, mini-hydro technologies, and wind, the focus of the government will be on:

- (i) Promotion of exploitation and utilization of mini-hydro wind energy and solar resources;
- (ii) Support to the local research and development with the aim of reducing the cost of renewable energy technologies;
- (iii) Provision of tax incentives for the importation of equipment for developing renewable energy projects;
- (iv) Giving support to the application of decentralized off-grid substitute technologies (for example wind and solar PV) in situation where competition exist.

#### 4.3 Main Institutions in Renewable Energy Resources Sector in Ghana

The institutional framework of the energy sector and the related human capacities as per the design are to aid large-scale energy infrastructure that is centralized. For different parts though, renewable energy development needs other decentralized governance approaches including creating new policies, regulations and plans in catalysing the active involvement of new actors in the public and private domain. Additionally, the development of renewable energy plans fundamentally requires changing the roles and responsibilities of the major actors which makes up the energy sector institutional framework<sup>[13,19,23]</sup>. Figure 1A below shows total primary energy supply in Ghana from 2000 to 2019.

#### 4.4 Key Energy Stakeholders and Institutions

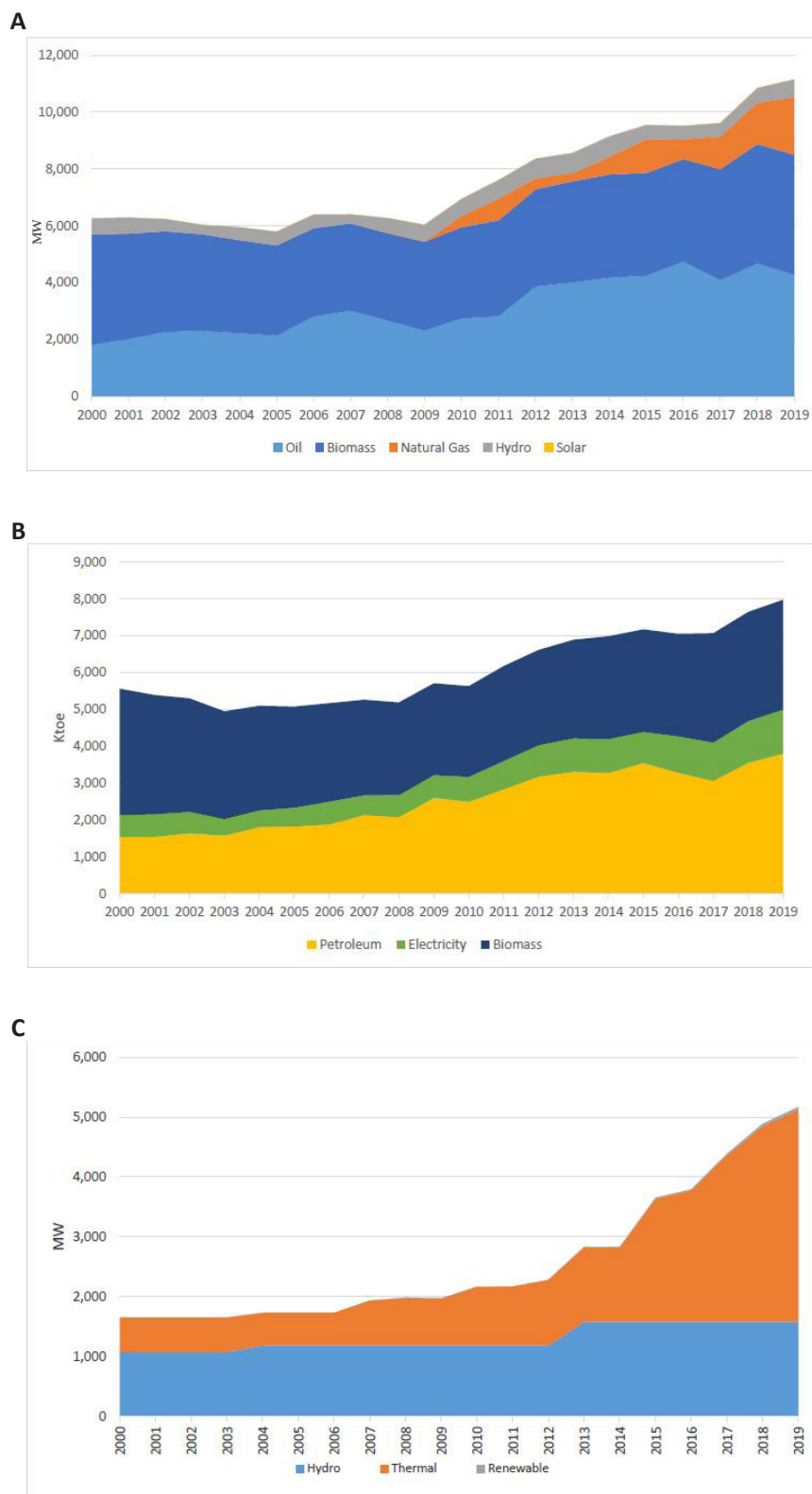
The energy system in Ghana is under the management of the public sector. Ministry of Energy has a responsibility to oversee the formulation, implementation, monitoring and evaluation of policies of the energy sector. Volta River Authority (VRA) and Bui Power Authority are owned by the government and generate a capacity of 5,082.82MW<sup>[80-82]</sup>. Ghana Grid Company (GRIDCo) is responsible for the management of the transmission of national electricity supplies as well as system operation to the industries and mining companies in addition to the two VRA electricity distribution companies; Electricity Company of Ghana and Northern Electricity Distribution Company (NEDCo)<sup>[1,32,80]</sup>.

Some regulatory agencies have been formed through the act of parliament to ensures every actor in the energy sector carries out their roles efficiently and provides a conducive environment for the protection and enhancement of private investment in the energy sector. The agencies are Energy Commission, Public Utilities Regulatory Commission (PURC) and the National Petroleum Authority. The Energy Commission is responsible for advising the government about the energy policy and strategy. Furthermore, it is part of indicative planning of the energy and expansion of electricity systems and licensing of energy sector operators. PURC was formed in 1997 and is the prime body used in setting up the tariffs and framing of service regulations of the customers. The National Petroleum Authority is however, an independent regulator. It reviews the world market price including the imported finished products and Ghana's oil refinery<sup>[33,81-83]</sup>. There are also many active non-governmental organizations within the sector, institutes of research and higher education institutions, and industry associations that are engaged in some activities related to renewable energy. Among those activities are promoting renewable energy, research and deployment in renewable energy<sup>[33]</sup>. Figure 1B and 1C shows total final amount energy consumed and electricity generation by fuel source from 2000 to 2019 in Ghana respectively.

#### 4.5 Obstacles of Increase Usage of Renewable Energy in Ghana

The desire for conventional fuels has heightened environmental concerns and government and policymakers have been forced to transition to renewable energy technologies due to the economic consequences. As a result, there is increasing daily energy requirements of populations worldwide. Hence, the need for energy and related services to support human, social and economic development, well-being and health is growing. Use of renewable energy helps combating climate change which is a great idea, but it must be sustainable to fulfil future generations' energy demands. As a result, renewable energy policy has been developed and structured in a way that encourages the use of renewable energy technologies. Meanwhile lack of ability to fully harness renewable energy resources is attributed to the following factors:

- (i) Absence of legal renewable energy policy and regulatory framework
- (ii) Lack of access to credit and long-term finance
- (iii) Absence of an all-inclusive rural electrification policy
- (iv) Lack of appropriate technical capacity for the maintenance of renewable energy systems
- (v) Low level of research, development, demonstration and deployment on renewable energy



**Figure 1. Energy and electricity generation in Ghana from 2000 to 2019.** A: Total primary energy supply in Ghana from 2000 to 2019. Source: Energy Commission, 2020<sup>[31,79]</sup>, B: Total final energy consumed from 2000 to 2019. Source: Energy Commission, 2020<sup>[31]</sup>, C: Electricity generation by fuel source from 2000 to 2019. Source: Energy Commission, 2020<sup>[31]</sup>.

#### 4.6 Absence of Legal Renewable Energy Policy and Regulatory Framework

In spite of the commitment from the government to develop renewable energy, the lack of an inclusive legal and regulatory framework has been a key challenge

for the independent power producers in investing in renewable energy technologies. For example, the lack of network access rules and transparent network pricing framework has hindered the growth of renewable energy<sup>[8]</sup>. The government's strategy is

**Table 1. SWOT Analysis of Current Situation of Renewable Energy in Ghana**

| Strengths                                                                                                                                                                                                                                                         | Ref.    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Ghana has a high potential for wind and solar energy due to its favourable climatic conditions of intensive solar radiation and high wind speed                                                                                                                   | [3]     |
| Ghana is politically stable hence provides a good working environment for investors                                                                                                                                                                               | [3]     |
| Vast unoccupied land that can be used for putting up of renewable energy infrastructure                                                                                                                                                                           | [3]     |
| Ghana has good policy framework such as Renewable Energy Act that promotes the development of renewable energy                                                                                                                                                    | [3]     |
| Availability of research institutions that trains students on renewable energy                                                                                                                                                                                    | [3]     |
| Open opportunity for private investors to invest by reduction of the tax rate                                                                                                                                                                                     | [3]     |
| Weakness                                                                                                                                                                                                                                                          |         |
| Licensing of regenerable energy projects is cumbersome and costly hence making investors to shy away                                                                                                                                                              | [3,84]  |
| Lack of awareness about the potentials of renewable energy in Ghana hence people do not invest in it                                                                                                                                                              | [3]     |
| Lack of financing for solar consumers                                                                                                                                                                                                                             | [85]    |
| High cost of setting up the renewable energy due to high interest rates charged                                                                                                                                                                                   | [3,86]  |
| Loss of power while it is distributed                                                                                                                                                                                                                             | [3]     |
| Poor access to the grid limits the upgrading the network to high quantum of renewable energy                                                                                                                                                                      | [86]    |
| Lack of technical skills to operate and maintain the renewable energy systems and technology                                                                                                                                                                      | [86,87] |
| Absence of all-inclusive energy policy has affected the distribution of renewable energy technology in rural areas.                                                                                                                                               | [90]    |
| Opportunities                                                                                                                                                                                                                                                     |         |
| Climate change awareness hence there is a need of promoting renewable energy to reduce the negative effects to the environment                                                                                                                                    | [3]     |
| Availability of funds such as Climate Investment Funds (CIF), Sustainable Energy Fund for Africa (SEFA) and the Global Environmental Facility (GEF) these funds are used for financing renewable energy particularly reducing GHGs and develop sustainable energy | [3]     |
| Increasing electricity demand in industrial, residential, and commercial sectors with an annual growth rate between 10 and 15% per annum hence there is need of increasing the supply of electricity through renewable energy                                     | [3]     |
| The prices of renewable energy equipment's are reducing hence this is an alternative cheaper method of generating electricity                                                                                                                                     | [3]     |
| Regional integration of the West African states in form of (ECOWAS) will help to consolidate the region's power generating sources to boost the supply of electrical                                                                                              | [3]     |
| Threats                                                                                                                                                                                                                                                           |         |
| Subsidizing fossil fuel hinders people from using alternative energy sources of renewable energy                                                                                                                                                                  | [3,86]  |
| Changing climatic regions will affect the production of renewable energy that depend on weather                                                                                                                                                                   | [3]     |
| Unreliable and inefficient data on renewable energy hence limiting development and large-scale production on renewable energy                                                                                                                                     | [3]     |
| The current land ownership system (customary, public and vested) in Ghana poses as a huge threat to the development of renewable energy, particularly solar and wind that require large and accessible area of land                                               | [3,84]  |
| Inconsistency in the policy leads to lack of implementation of previous projects                                                                                                                                                                                  | [3]     |

to encourage the expansion of mini-hydro and other mini-grid-connected renewable energy. However, the lack of well-documented tariff principles and a lack of sufficient regulatory capacity for mini-grid systems have consistently operated as roadblocks. Moreover, no incentive is available for developing stand-alone systems due to the absence of an appropriate pricing framework that enables the system to resell power to the electric distribution company<sup>[32,84,85]</sup>.

#### 4.7 Lack of Access to Credit and Long-Term Finance

Another challenge is the reluctance that generally exists among the local banks and other institutions of finances regarding the financing of renewable energy

technologies<sup>[5,86-88]</sup>. Ghana has a financial sector that is well developed and comprises more than 25 banks, which are grouped into commercial, merchant and development banks and has an average of 310 branches within the country. Despite this, financial provision and accessibility to long-term credit have not been avail to the sector of renewable energy because of the following:

- (i) The renewable energy project is perceived to be a risky venture
- (ii) Lack of sufficient funds present at the bank
- (iii) In adequate experience and deep knowledge by the bank staff on how to perform a credit risk analysis of the renewable energy project
- (iv) Lack of ability by the private entrepreneurs and

the energy service companies (ESCOs) in presenting bankable proposals.

#### 4.8 Absence of an All-inclusive Rural Electrification Policy

Energy policy even though covers the renewable energy sector, the policy does not clearly define the rural electrification policy compared to the grid extension plans and off-grid programmes. The gap in the policy has impacted the deployment, diffusion and commercialisation of renewable energy technologies among the communities in rural and peri-urban areas<sup>[34,44,89,90]</sup>.

#### 4.9 Lack of Appropriate Technical Capacity for the Maintenance of Renewable Energy Systems

Weakness in technical capacity among the private entrepreneurs has been identified as a barrier, specifically in solar PV systems. Addressing this requires international support and cooperation to generate required change technologically and enhance the country's capacity to embrace renewable energy<sup>[34,35,91,92]</sup>.

#### 4.10 Low Level of Research, Development, Demonstration and Deployment on Renewable Energy

The key barrier to research and development, demonstration and deployment (R&DDD) on renewable energy is the absence of the Ghana Government policy directive that can drive and give direction to research and development activities on thematic areas that have been specified on areas which include renewable energy<sup>[93-96]</sup>. In addition, the funding from the Government of Ghana for R&DDD activities in the renewable energy sector is insufficient. In contrast, the strategic framework for attracting funding for the private sector for R & R&DDD is not yet developed. Moreover, there is weakness in the linkage between industry and institutions of research or the universities which can advance R&DDD activities and offer technological needs of the industry<sup>[97,98]</sup>. Henceforth, R&DDD has performed a limited role in driving the development and deployment of renewable energy in Ghana. In addition, there is weak and inefficient sharing of information in the renewable energy sub-sectors which has resulted in the partners in the renewable energy industry lacking the interest in R&DDD<sup>[36,37,99,100]</sup>.

#### 4.11 Merits of the Renewable Energy Issues in Ghana

Renewable Energy Technologies, particularly PVs, can reduce the country's dependence on centralized power from hydro and fossil fuel sources<sup>[101]</sup>. The existence of a regional integration network in the sub region and the increased electrification demand in some areas is a great opportunity in the development of the renewable energy resource. As a result, people develop confidence of the reliability of the renewable sources hence increasing their chances of adopting it<sup>[3,102-104]</sup>. The Ghana national agenda to achieve

10% increase in renewable energy utilization by 2030 has increased the awareness of the public social acceptance and making the aware of the benefits. Citizen's acceptance to the use of renewable energy increases the demand for the energy and therefore giving confidence to the financing institutions to invest on the resource<sup>[105]</sup>. The national policy emphasizes on regenerating biofuels and on the other hand the country has great potential in biomass a management and generating energy from waste hence greater advantage for renewable energy in the country<sup>[106]</sup>.

#### 4.12 Authors' Views on the Development of Renewable Energy

Ghana has an active power generation system and both the public and private companies are involved in it. Electricity access in the country is increasing from time to time diversifying to rural areas and surpassing the demand. The adoption of renewable energy in the country has played a significant role in addressing the increasing energy demand and providing clean and reliable energy. The country adoption to Sustainable Development Goals (SDG) 7 by the UN which targets on ensuring access to affordable, reliable and modern energy services, increases the use and utilization of the renewable energy with more people embracing it. The incorporation of renewable energy in Ghana plays an important role in addressing the rising energy demand by the replacement of non-renewable fuels to clean and reliable fuels benefiting the local communities.

### 5 CONCLUSIONS

The review utilized a rapid review approach to analyse information. The findings of the study showed that Ghana has the potential in producing renewable energy. If renewable energy sources are well utilized, they can suffice and more than two-thirds of basic energy is consumed in Ghana. Currently, the potential of renewable energy used in Ghana is estimated to be not more than 20% and the major one is hydropower. Among the major reasons for the neglect of the renewable energy sector in Ghana's overall usage is the absence of legal and technical regulation and framework that can act as a stimulant and land acquisition. Despite this, the Ghanaian Government recently made some strides in the renewable energy sector by adopting some legislation aimed at improving the feasibility of the economy in the production of energy through renewable energy sources and government acquiring land compulsory and compensation. Legislation such as the Renewable Energy Act of 2011 seeks to provide the legal and regulatory framework needed for developing and expanding Ghana's sub-sector of renewable energy. In addition, various sectors of the economy have also implemented policies having components on the development and utilisation of substitute energy, specifically renewable energy<sup>[1]</sup>.

Additionally, Ghana ratified international legislation

such as the UNFCCC and the Kyoto Protocol. It expressed her commitment to achieving the obligation of the Convention. Both the UNFCCC and the Kyoto Protocol were supposed to reduce GHG emissions, with Ghana's aim being a 15% reduction in absolute terms. Ghana is also part of the ECOWAS White Paper concerning regional policy on the accessibility of energy services by the population in rural and semi-urban areas. Ghana has key institutions in the energy sector which are responsible for the management of energy systems. These include VRA and GRIDCo, NEDCo. Moreover, regulatory agencies have been created by the act of the parliament. However, several barriers that affect the utilization of renewable energy sources were identified and included absence of legal renewable energy policy and regulatory framework, lack of access to credit and long-term finance, absence of an all-inclusive rural electrification policy, lack of appropriate technical capacity for the maintenance of renewable energy systems and low level of research, development, demonstration and deployment on renewable energy.

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### Conflicts of Interest

The authors declared that there are no conflict of interest.

### Author Contribution

The authors confirmed contribution to the paper as follows: study conception: Takase M and Kipkoech R; draft manuscript preparation: Takase M and Kipkoech R. All authors reviewed and approved the final version of the manuscript.

### Abbreviation List

ECOWAS, Economic Community of West African States  
GHG, Greenhouse gases  
GRIDCo, Ghana Grid Company  
GSGDA, Ghana Shared Growth and Development Agenda  
MW, Megawatts  
NEDCo, Northern Electricity Distribution Company  
PURC, Public Utilities Regulatory Commission  
REEE, Renewable energy and energy efficiency  
SE4ALL, Sustainable energy for all  
UN, United Nations  
VRA, Volta River Authority

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