

## RENEWABLE ENERGY, A RESPONSE TO CLIMATE CHANGE.

### CASE STUDY LIBERIA

Butu LEVI\*<sup>1</sup>, Prof. Dr. Hüseyin Gökçekuş<sup>2</sup>, Assoc. Prof. Dr. Youssef Kassem, Ph.D.<sup>3</sup>

<sup>1</sup>Department of Environmental Science and Engineering, Faculty of Civil and Environmental Engineering, Near East University, Mersin 10 Turkey.

<sup>2</sup>Department of Civil Engineering, Civil and Environmental Engineering Faculty, Near East University, 99138 Nicosia (via Mersin 10, Turkey), Cyprus.

<sup>3</sup>Department of Mechanical Engineering, Engineering Faculty, Near East University, 99138 Nicosia (via Mersin 10, Turkey), Cyprus.

Article Received on 12/01/2022

Article Revised on 02/02/2022

Article Accepted on 23/02/2022

#### \*Corresponding Author

**Butu Levi**

Department of  
Environmental Science and  
Engineering, Faculty of  
Civil and Environmental  
Engineering, Near East  
University, Mersin 10  
Turkey.

#### ABSTRACT

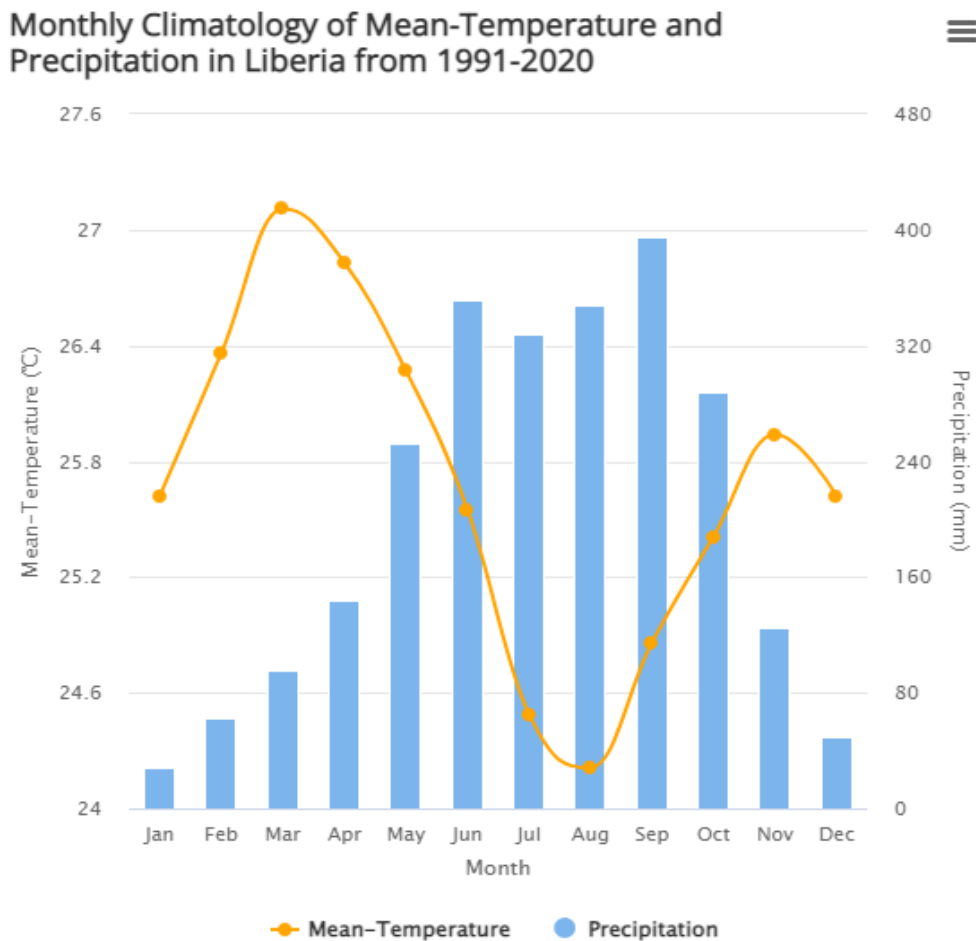
Now a day's climate change is constantly making an influence on the ecological condition of various countries. Climate change is making destructive impacts on the ecological conditions of various countries and Liberia is one of them. Liberia is an underdeveloped country with limited resources. Various institution of the world is continuously investing in the renewable sector of Liberia through which Liberia can overcome the influences of climate change. Liberia is responding against climate change through the help of promoting renewable

energy. With the huge investment of various institutions of the world, Liberia is enhancing their renewable energy sector which is the main source to overcome climate change in Liberia. Finding displays that Liberia is documented as extremely susceptible to climate change influences, graded 171 out of 181 nations in the Notre Dame-Global Adaptation Index of the year 2020.

#### INTRODUCTION

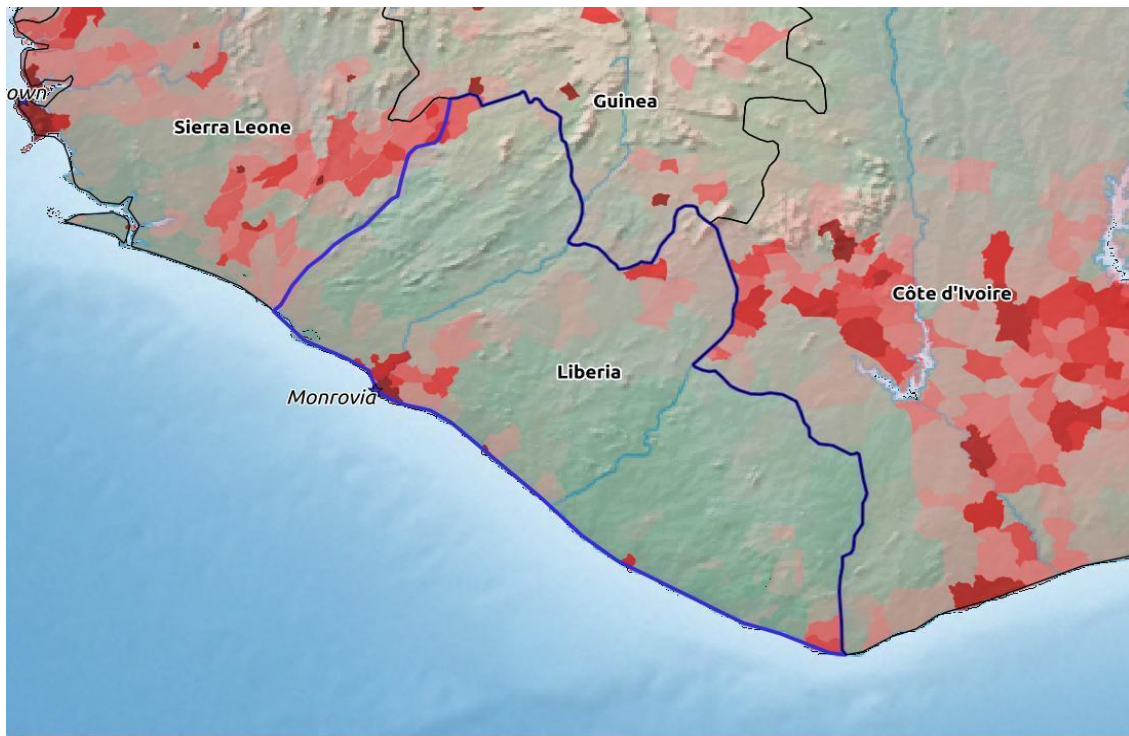
**Background:** Climate change is the most significant developmental and ecological problem of the current era. This apprehension imitates the authenticity which as a result of people's

activities is penetrating to the change in climate, and which familiarising to expected and present proportions of the change in climate possibly will be exact stimulating. Although, it similarly imitates the considerateness that human nervousness of the climate is fundamentally irreparable, for numerous eras at minimum (Verma, 2021). The amount to which future peers would be unprotected to the variation in climate will be resolved through the activities in which people conquer the impending eras to decrease people's influences on the system of climate. There is an identical durable form of indication, established on an extensive series of displays, that variation in climate is happening and the system of climate is warming up. The indication contains perceived upsurges in the global average temperature of the air and ocean, widespread melting of ice and snow in various parts of the world, and growing sea levels around the globe. It is slightly the extent of the influences and their consequences that endure indeterminate. Animals and plants are retorting to climate change in behaviors that are reliable with the perceived heating with consequences all over managed and natural environments (Acheampong, et al 2021).



Source: <https://climateknowledgeportal.worldbank.org/country/liberia>

In countries such as Liberia, the agriculture which is extensively dependent on the rain is the backbone of the economy's backbone. This type of agriculture is based on the patterns of climate, therefore these agricultural areas are endangered due to the risky weather activities. Liberia is motivated to encounter elementary enlightening requirements, like those acknowledged in the programs of national development and maintainable expansion objectives would barely be capable of attaining goals, consequently parting source of revenue at stake (Seward, 2021). Although, augmented occurrence of natural risks like destruction of coastal areas, worldly flooding, and damage of the forest of mangrove through ocean interruption. And related influences on wildlife and fishery are one of the most noticeable influences of the variation in climate in Liberia. Another noticeable influences of the variation in climate in Liberia are heightened the various type of diseases on the public health, damage of animal and plant biodiversity. Devastation and smaller lifespan of utilise of substructure and public services instigated through the flooding, increase in the level of ocean and overflow of swamp land, condensed the sources of renewable energy (RE). And damage the ability of mainly the community which is related to the farming. Moreover, for the government and the residents of Liberia, knowing the significance of addressing climate variation in expansion planning is far more important in the current era. The approach and procedure document of the change in climate is organised by the government of Liberia in order to make sure that climate change altered copy and extenuation problems are accepted at program level and in main cross sectoral and sectoral growth exertions (Arifin, 2018).



Source: <https://www.bluemarblecitizen.com/world-population/Liberia>

Climate change stances a thoughtful dare to the initial expansion of Liberia. The strategy creators of Liberia have evidently documented the risk that climate variation poses to Liberia. Although, the country is susceptible to the influences of climate inconsistency and variation. Like, warmer temperatures of the country, upsurges in yearly rainfall, and upsurges in the incidence of full rainfall proceedings. These variations in the climate display various challenges to Liberia's socio-economic growth (Seward, 2021). The country's low adaptive volume to react to the change in climate is in part because of the damaging effects of the civil fight which occurred in between the year 1989 to the year 2003. After the civil war, Liberia's government, with different global and nationwide organisation and establishments, has been compelling activities to improve, comprehend and discourse the challenges of climate change all over Liberia. Furthermore, outstanding requirements contain information on long-term and short-term climate change influences and susceptibilities in the interior of Liberia, in addition to the technological, financial and human resources to recognise adaptation urgencies and implement suitable adaptation strategies and plans (Argyrou, et al 2018).

Currently the Climate Investment Funds granted Liberia a funding of approximately 23.25 million dollars to assist convert the RE sector of Liberia. The current plan aims at emerging a 9.8 megawatt hydropower plant at the location of Gb In which will drop in the Mano River in Nimba region and deliver an inexpensive, reliable and suitable source of electricity to the

country. Although, the plan will be supported by the organisation named as “Scaling-up Renewable Energy Program”. It is simply a package below the Climate investment funds whose goal is to allow alteration in emerging nations through representing the social, economic and ecological feasibility of RE (Bunte, et al 2018). Additionally, Liberia has the lowest electricity admittance charges in the globe with fewer than 2 percent of family units having admittance to facility of electrical energy countrywide and consequently increasing admittance to electrical energy is not merely energetic but should be one of the nation’s uppermost urges. Climate investment funds have identified that the organisation will operate intensively with their energy professionals to make sure that the application of the plan initiates as soon as possible. AFDB professionals plan to mark a decrease in utilisation of extremely polluting impartial diesel generators which are serious in powering not merely businesses of Liberia and households but similarly in refining the conditions of education and health substructure (Macusi, et al 2020). Furthermore, Liberia endures improving as of the year 2014 Ebola Crisis, these particular financial incomes will assist the Liberia’s to arrange their own infrequent incomes into those subdivisions of the economy and community which have agonised significantly with the depression caused by this awful disease. AFDB is powerfully dedicated to funding Liberia in converting Liberia’s energy sector subsequent to this endorsement of the Climate Investment Funds. The electrical energy to be produced by the Gbedin Drops hydro power plant will be conveyed through the current Liberia cross-border communication streak. Grounded on the yearly average families’ electrical energy ingesting that presently stands at 510 kWh for an average household of five individuals, it is projected that the plan would distribute electrical energy to around 500,000 individuals (Azadi, et al 2019).

### **Problem statement**

Climate change is continuously influencing the world and especially the underdeveloped countries. Temperature of the earth is rapidly increasing day by day. There could be many solutions to control climate change and every country is responding in their own way. Renewable energy response to climate change in Liberia has not been explored yet. However, the current research studies renewable energy as a response to climate change. Other studies are limited to the influence of climate change in developed countries. Yet this current study has identified renewable energy as a response to climate change in Liberia.

***Research Aim***

The aim of research is to examine renewable energy as a response to climate change in Liberia.

***Research Objectives***

Following are the research objectives which are given below:

- To identify the influence of renewable energy as a response to climate change in Liberia.
- To identify the relation between renewable energy and climate change.
- To identify the ways to reduce the influences of the change in climate worldwide.

***Research Questions***

- What is the influence of renewable energy as a response to climate change in Liberia?
- What is the relation between climate change and RE?
- What are the ways to minimise the impact of climate change on the globe?

***Significance of study***

Climate change is the biggest issue on the globe. The reasons behind the climate change are Greenhouse Gases, Absorption or Reflectivity of the energy of sun, variations in the orbit of the earth and Rotation, changes in solar events, variations in the Reflectivity of earth, volcanic events, and variations in naturally happening CO<sub>2</sub> absorptions. Many underdeveloped countries are being affected by climate change tremendously. This research identified renewable energy as a response to climate change in Liberia. This would be significant for the people who want to minimise the climate change in their countries. Many of the underdeveloped countries of the globe will benefit from this study. This study could also be beneficial for the government of Liberia as they could find more things through this study to overcome the climate change in the country.

***Limitations of Study***

This study on renewable energy as a response to climate change is limited to Liberia. Although, there is also a need to research on other various underdeveloped and poor countries who are continuously affected by climate change around the globe. Such as Dominica, Vietnam, Nepal, Pakistan, Bangladesh, Myanmar, Haiti. These underdeveloped countries are needed to find ways of protection from the influences of climate change.

### *Literature Review*

According to the research done by (Macusi, et al 2020) it has been demonstrated that with the developing severity of climate change (CC) and well-known apprehension between the world level communities, a lot of states have used their energy plans to improve the percentage of renewable energy (RE). Renewable energy has importantly advanced above the previous period due to the various forces. In 2010–2019, international non-hydro investment of renewable energy was about \$2.6 trillion; funds in wind and solar energy got about \$1.3 trillion and \$1 trillion, respectively. In 2018, the international's improved investment in renewable energy was about \$332.1 billion. This price was about 5.38 times the level in 2004. In 2017, the power of renewable energy accounted for about 70 per cent of the newly installed power capacity of the world, and renewable energy accounted for about 10.4 per cent of the global energy consumption. Of this whole, renewable energy hydropower and electricity accounted for 5.4 per cent and 3.7 per cent respectively. By 2017, 179 states had planned renewable energy developing goals, and 57 states had proposed 100 per cent renewable energy targets of electricity share. Such as, the European Union (EU) has stated that its memberships would meet 20 percent of their demands of energy with renewable energy by 2020. The government of Germany has described strategies to develop the share of renewable energy in its system of energy from 33 per cent in 2018 to 40 per cent 45 per cent and 55 per cent 60 per cent by 2025 and 2035, respectively (Smith, 2021). In 2019, renewable energy of Germany electricity generation (EG) got its goal ahead of agenda, accounting for over 40 per cent of the overall EG. In the United Kingdom, renewable energy currently gives 40 per cent of its overall electricity supply (ES), while coal fired EG let fall to 2 percent of the overall. Consistent with the 13th 5-Year Plan for Renewable Energy Development, China's renewable energy use would reach about 730 million tons of equal regular energy by 2020, and renewable energy power would create up to 27 per cent of the overall EG (Wang, et al 2018). Despite such development, renewable energy improvements in states around the globe continue at the trial level, defined as “crossing the river by feeling the stones”. Path selection, strategy development, and rules have as well be cautious. This nervousness has made many difficulties in choosing a direction of country and path by admiration to development of renewable energy. An improved consideration by this procedure will assist remove various interfering items, stable policies, and formulate effectively, and develop the supportable increase of renewable energy (Adams and Acheampong, 2019).

With respect to the study done by (Brockway, et al 2019) showed many situations to forecast future renewable energy progress on an international scale. The result is that rules of climate will place limitations on the scale of renewable energy advances and the scale of renewable energy will as well be influenced by alterations of technic in renewable energy and the capability of renewable energy to mix by conformist energy systems (ESs). (Saint Akadiri, et al 2019) established that the policy of the government is the main problem motivating renewable energy increase. Making the policy of the government is significant for renewable energy increase. But the impacts of these rules importantly contrast in various levels of renewable energy development of the industry. Meanwhile, (Argyrou, et al 2018) stated that advancing and developing technologies of renewable energy needs a long procedure. Administrations of all states are necessary to introduce targeted incentive rules for renewable energy through this procedure. Carbon production easing rules have as well-motivated renewable energy improvement in China to contract by the emissions of carbon dioxide top in the upcoming. A hard consideration of strategy-driven renewable energy improvement is required to rules of design within the upcoming. Explanation on the involvement of the present rules to renewable energy improvement is more significant than the cost of the strategy practice. Moreover, (Ebhotu and Jen, 2020) argued that increased awareness of the tools of how research and development strategies to fund photovoltaic (PV) advance internationally and talk over the issues reasoned by these research and development strategies. Based on this research, different research and development struggles would concentrate on PV electricity penetration, system integration technology, and PV technology improvement. The decrease of strategy favoring power as well has important impacts on renewable energy improvement. A growing amount of research is trying to moderate this kind of impact with optimisation of strategy favors. (Pietrzak, et al. 2021) considered the optimisation of food-in cost rules by the decrease of support to wind turbines believing the stop by subsidies to renewable energy improvements. (Kim, 2021) stressed the requirements for demand-kind rules and green documentation dealings within China. Limited administration preferences are differentiated in the renewable energy improvement procedure, so power to differentiated policy requirements. Instances contain requirements for investment-oriented rules to motivate the growth of associated sectors, demand-oriented rules to meet necessities of clean energy, and resource-oriented rules to encourage the use of renewable energy assets (Basias and Pollalis, 2018).



According to the study by (Chowdhury, et al 2018) there are many types of research on the description of weakness. Based on the suggestion of weakness in IPCC 2001. (Chu, 2021) compound the publicity unit and feeling unit into a modern unit namely 'Potential impacts' and sketched the susceptibility map for a network. Through going over the increased threat by the vulnerability idea, (Azadi, et al 2019) created the common theoretical structure for CC weakness study and highlighted the local adaptive capability of a system. Based on the report in IPCC 2007, vulnerability is the point to which a method is at risk too, and incompetent to manage by, adverse impacts of CC, containing variability of climate and limits. Vulnerability is a purpose of the magnitude, nature, and degree of CC and the difference to which a method is visible, its feeling, and its adaptive capability. Moreover, vulnerability is a purpose of 3 major scopes: coverage to definite social and/or environmentally friendly enterprises, linked adaptive capacities, and associated sensitivities and stressed the local adaptive capability essential within the system. This labor assisted the structure of equal international alteration vulnerability valuations for a vulnerability scoping diagram and its app to a case study famous as the HERO scheme. Currently, the vulnerability scoping map has a well-known app within the grounds of administration of the community, coastal tourism, water systems and brownfield regrowth. Consistent with these ideas of vulnerability, they describe the vulnerability of renewable energy in 3 scopes: publicity of renewable energy to CC, feeling of renewable energy to CC and adaptive capability of the renewable energy system, the careful indications of which would be complete as follows (Batel, 2020).

### **Experience of Renewable energy to climate change**

According to the study by (Egli, et al 2018) it has been identified that the experience in place of a renewable energy system of the state is focused on the change in climate because of anthropogenic intimidations. Experience is projected utilising notches of growing influences which measure the risk to the renewable energy system of the state as a bunch of four mechanisms. Specifically, the exposure of RE can be separated into 5 different mechanisms, explicitly past indications on life-threatening weather proceedings, the condition of land utilisation, economic experience, population experience and the experience of energy construction. Life-threatening proceedings mention the incidence of storm airstreams, life-threatening rainstorms, frozen and floods that directly imitate the potentials of life-threatening proceedings in the immediate future. Moreover, the land utilise item, signifies the variations of landform that has influences on hydropower and wind power generation and is signified through the coverage of the forest. Energy assembly experience is the quantity of

renewable energy in a single state. Furthermore, population and economic experience are quantified correspondingly through the local gross domestic product each unit zone and population concentration increased through the average of renewable energy utilisation in a single region, suggesting that the energy assembly experience is personified in the population and economic experience. Therefore, the experience unit is shortened into 4 mechanisms: land utilisation, life-threatening proceedings, exposure of economic and population (Bromley and Poe, 2020).

### **Kindliness of RE to climate change**

One of the most key arguments made by (Hou, et al 2018) is that kindliness is simply the mark to which an area is contingent on renewable energy. For a single area, the requirement on climatic factors and renewable energy (containing wind, rainfall, temperature, sunshine and humidity), that are nearly associated with the growth of renewable energy, are selected to quantify the kindliness of renewable energy to the variation in climate. Although, the climate fundamentals are designated as the generally suitable pointers of kindliness because of the devoted association among renewable utilisation and these climatic features. Wind power, hydropower, solar power and extra types of renewable energy generation are thoroughly connected to the unchanging obligation for the climatic features wind speed, rainfall, humidity, sunshine etc. The present installed volume measures of renewable energy in each unit zone are usually forced through the outlines along with the variations of climate variables, and therefore are subtle to climate change. Furthermore, the compensations of renewable energy technologies powerfully are contingent on the climate of the connection place (Brockway, et al 2019).

### **Benefits of Renewable energy technologies**

The study discussed by (Batel, 2020) has identified that the RE technologies have well recognised benefits which are given below:

- Refining ecological sustainability.
- Refining the health of the community.
- Resolving the unemployment issue.
- Financial assistance.

The usual value of accomplished solar photovoltaic systems has fallen 33 percent in the meantime of the year 2011, and the value of electrical energy produced as of wind similarly fallen in excess of 43 percent in the 4 years of recent past. As the economic prices of RE

technologies have reduced and are nowadays inexpensive with old-style electrical energy bases in many areas around the world. Possibly one of RE technologies utmost benefits, though, is the cost they carry for extenuation of conservatory gas releases and the attendant climate change. Although, these two international conservatory gas releases and international distinctive CO<sub>2</sub> meditations are growing quickly. The subsequent climate variation is well recognised with a great sureness as are the negative influences on socio-economic and natural systems. It containing: heat waves and high temperatures and which consequence in thousands of demises as of hyperthermia, crop disasters which worsen worldwide starvation, power outages, increasing the levels of oceans. Climate change cause below sea level coastal zones to plunge slowly, destruction of coastlines, augmented danger of flooding, and saltwater interruption, sturdy storms. It cause extra loss to coastal surroundings, augmented danger of floods, deficiencies, and fire. These undesirable externalities have been exposed to be owing to human actions with the sureness level of 95 percent (Chang, et al 2019).

### **Climate change influences on RE generation**

According to the study conducted by (Perera, et al 2020) has identified that renewables will surely be important in a low-slung carbon forthcoming. In Order to meet the 2 degree centigrade climate objective, the portion of RE in the ultimate utilisation of energy must increase from 19 percent in the year 2017 to 65 percent by the year 2050. Previously, the portion of RE in electrical energy production must be approximately 85 percent, up from a projected 25 percent in the year 2017. Although, the physical influences of the change in climate are amid the encounters that renewables will have to look at, as renewables have insinuations for the dependability and presentation of the energy system. Preliminary various researchers (Zhou, et al 2021; Killer, et al 2020; Gbatu, et al 2019) on this particular issue talked about the susceptibility of the energy subdivision as a request viewpoint, however there are a rising number of researchers examining influences on the contribution of energy too. Conduction lines and other zones laterally the cost cable of the energy subdivision can similarly be pretentious. Another reason why the subdivision of energy has established so much consideration in the literature is for the extended lifetime of the infrastructure of energy. Within the subdivision of energy, renewable generation is the focus of various countries, because the circumstance that the chief reserve is directly associated with climate variables like temperature, precipitation, wind, or irradiation. Water is also an important variable, as its obtainability not only disturbs hydroelectric power plants, however similarly

any generation plant that is contingent on water for a portion of its procedure, including carbon storage and capture or including thermal generation (Chowdhury, et al 2018).

### **Technological change of RE development**

According to the research done by (Killer, et al 2020) it has been demonstrated that the rate of technology is very significant to huge-size usage and market achievement for renewable energy. (Chang, et al 2019) focused on variations in the rate of renewable technology and its impacts. (Yu, et al. 2021) examined the cost of enhancement in wind turbine, photovoltaic, and various other low carbon power technologies. Although, renewable energy growth is importantly restricted by its fundamental power rate and implementation means. Exogenic ecological rates occur for the whole energy, including renewable energy. Consequently, renewable energy improvement should be systematically evaluated to prevent substantial damage to the natural environment. (Chang, et al 2019) established perceptions into the circumstances that make decreases in the rate of renewable energy technology depend on the technological process, sales, and corporate capital investments (Chu, 2021).

## **RESEARCH METHODOLOGY**

### **Research Approach**

The research approach is an idea and process which contains the various steps of wide-ranging assumptions to comprehensive approaches of gathering the data, analysis of the collected data, and interpretation of the collected data. It, consequently, depended on the dissertation's nature and the issue being adopted. To select an accurate research approach to undertake the research that is most significant for the researcher. The inductive research approach has been selected by the researcher to undertake this dissertation. While the inductive method requires commencing with a collection of experimental explanations, taking samples in individual's studies and also hypothesising around individuals designs (Cantarero, 2020).

### ***Research Methodology***

Research methodology is the particular methods or procedures utilised to recognise, choose, develop, and examine knowledge about a matter. In this dissertation the researcher has selected the qualitative research approach to undertake the research. Although, the qualitative research approach is multiple components focused, including an interpretive, realistic strategy to the topic of the dissertation. This simply means that the researcher who selects the qualitative approach to research the topics in their natural settings, interpret, or try to put up

perception of events in conditions the association's individuals give to them (Dufo-López, et al 2019).

### **Data Collection**

Collection of Data is the main function which is done by the researcher to undertake the dissertation. Collection of data is the procedure of collecting and quantifying collected data on variables in a created method, which later makes the researcher able to answer significant questions and assess results. Collection of data has two type which are given below (Ebhotu and Jen, 2020):

#### ***Primary data collection***

Primary data is a kind of information that is accumulated by scientists immediately from major resources through discussions, evaluations, research, etc. Primary data are generally accumulated from the resource wherever the information initially created and are considered as the finest type of statistics in exploration (Egli, et al 2018).

#### ***Secondary data collection***

In this dissertation the researcher has collected the data through the secondary data collection method. Because while the information is gathered by somebody as well for a reason other than the scientist's recent venture and has now experienced the arithmetical evaluation is known as Derived Statistics (Fashina, et al 2018).

### **Data analysis**

Data analysis is the extremely essential piece of every examination. Data analysis encapsulates accumulated information. It entails the clarification of statistics assembled over the usage of systematic and analytical interpretation to establish designs, connections, or developments. In this dissertation the researcher has selected the descriptive analysis method. To undertake this specific research the research has analysed the government report and interpreted the data according to the topic of the dissertation (Gbatu, et al 2019).

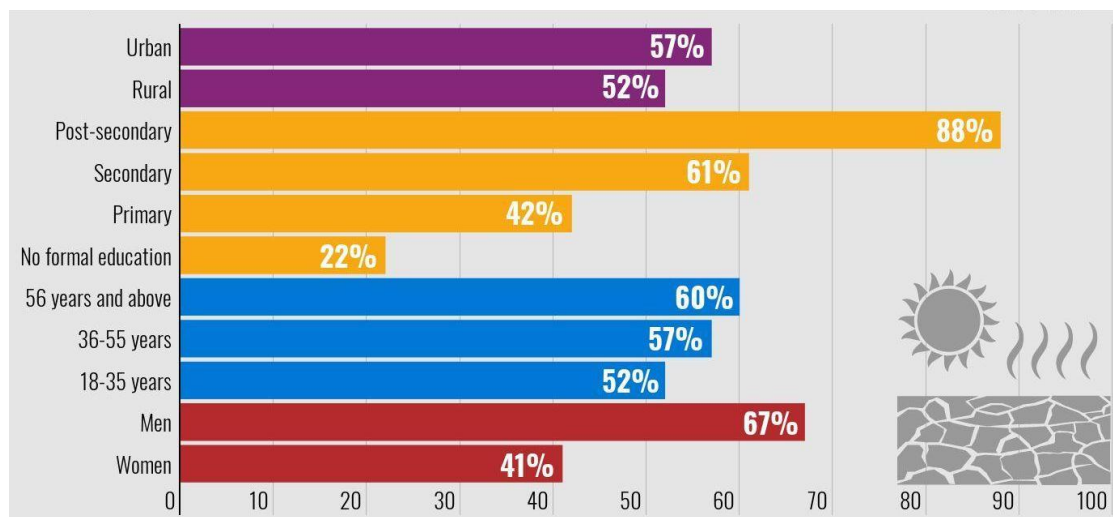
#### ***Ethical consideration***

Ethical consideration is a gathering of values and principles which must be followed during the research on any topic. Although, the ethical considerations ensure that no individual action in any way is damaging to the respective community or an individual of the society. It

abstains organisations and individuals from pandering in cruel behavior. (Halperin and Walton, 2018).

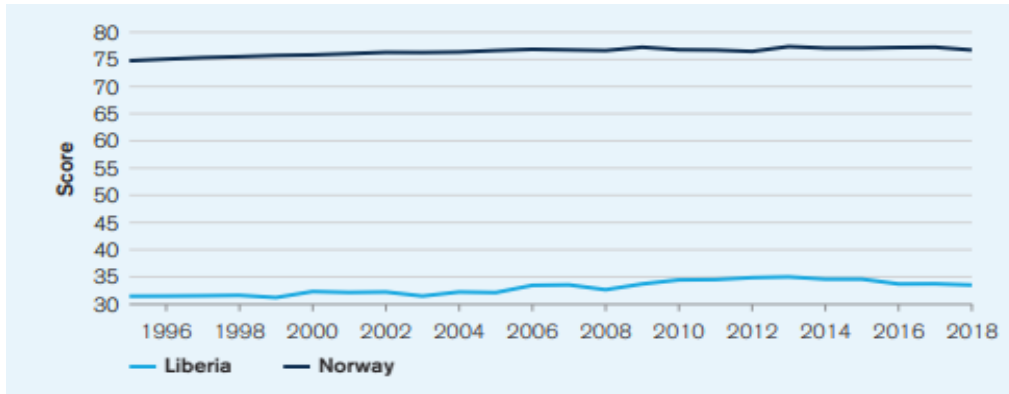
## RESULTS

In Liberia, electrical energy, fuel products, biomass are extensively utilised in the sector of energy intended for a diversity of uses like; home heating and cooking, transportation, lighting, manufacturing, and motive power. However, yearly utilisation of forested biomass was projected at approximately 10.8 million for firewood, and around 36,500 tons for charcoal. Liberia has augmented their energy cohort from approximately 2,045,644 KW in the year 2006 to around 19,554,334 kWh in the year 2009. Fuel products utilisation for the year 2008 was the same to around 8,450 TJ of energy (Martins, et al 2018).



Source: <https://www.irena.org/publications/2021/Aug/Bracing-for-climate-impact-2021>

The Liberia's government has evidently acknowledged the danger that climate variation in Liberia stands to Liberia, predominantly to Liberia's 7 in ten residents who are determined by the agriculture sector to live and to survive in the world. Additionally, various experiences of flooding in the present era, variation in the pattern of rainfalls, augmented temperatures, and extra climate variations have serious consequences for food safety but similarly for education, health, and other growth subdivisions of Liberia (Macusi, et al 2020).



Source:[https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB\\_Liberia%20Country%20Profile-WEB%20%281%29.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf)

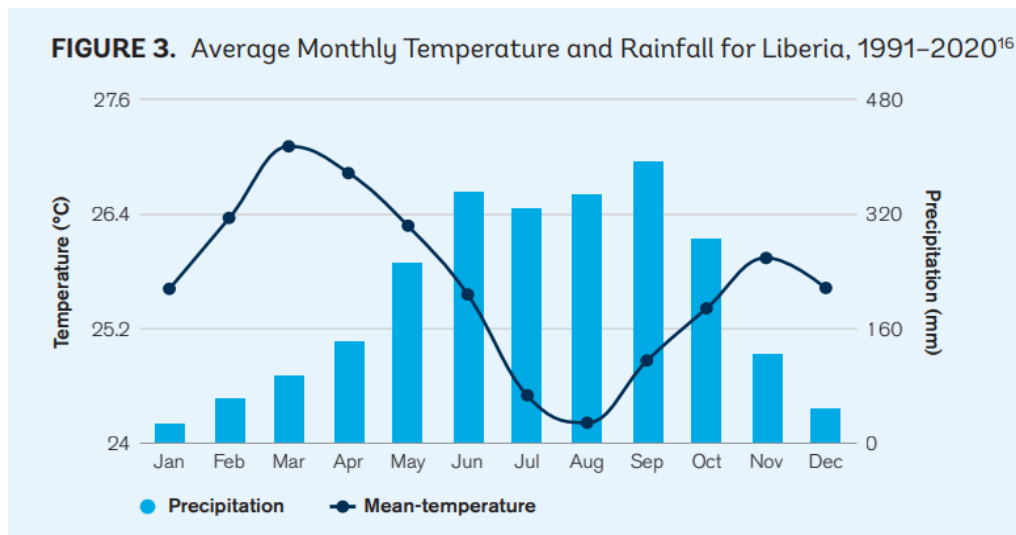
The Notre Dame-Global Adaptation Index positions around 181 nations utilising a mark which analyses a susceptibility to climate change and supplementary world encounters along with their eagerness to recover pliability of the countries. Above displayed Notre Dame-Global Adaptation Index purposes to assist various public subdivisions better recognise susceptibility and eagerness orderly to improve line up investment for extra effectual comebacks to the world challenges. Due to an amalgamation of geographic, political and social influences, Liberia is documented as extremely susceptible to climate change influences, graded 171 out of 181 nations in the Notre Dame-Global Adaptation Index of the year 2020. The additional susceptible a nation is the lower their mark, whereas the additional prepared a nation is to recover its pliability the complex it will be (Perera, et al 2020).

Climate Variables	1991–2020
Mean Annual Temperature (°C)	25.7°C
Mean Annual Precipitation (mm)	2,467.07 mm
Mean Maximum Annual Temperature (°C)	31.2°C
Mean Minimum Annual Temperature (°C)	20.3°C

Source:[https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB\\_Liberia%20Country%20Profile-WEB%20%281%29.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf)

Liberia is among the rainiest nations of the world, with substantial rainfall happening from May to October. Average of yearly rainfall of Liberia is comparatively high, approximately above 2,500 millimeters annually. Rainfall is uppermost end to end in the coastal areas, but declines to internal flat terrain and low mountains of Liberia, where average rainfall influences around 2,030 mm each year. Southern area of Liberia receives rain year-round, whereas the rest of the nation is affected 2 times of year because of the West African

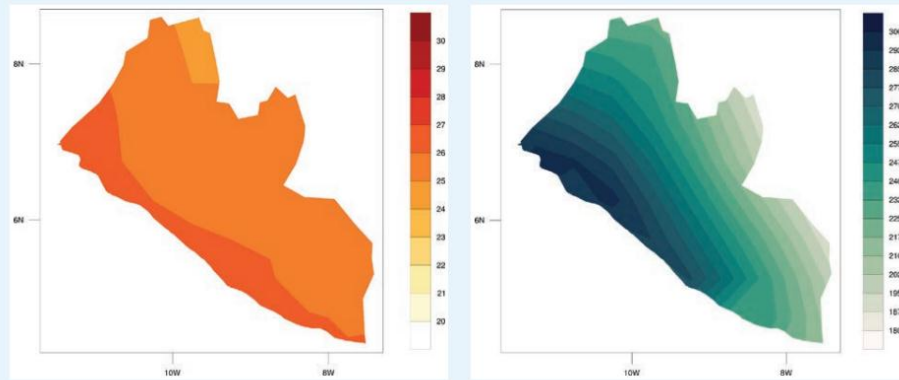
Monsoon. The rainfall season naturally happens in May and November in the summer season, with regular temperatures of 25°C. The dry period of the year naturally happens in December to April in the winter season. The winter period is conquered through the winds of harmattan with regular temperatures amid 24°C to 27°C. Moreover, comparative humidity extends 90 percent to 100 percent throughout the raining period and approximately 60 percent to 90 percent throughout the winter period of the year. Examination as of the Climate Change Knowledge Portal above given table, largesse the newest climatology, mean yearly temperature for Liberia is approximately 25.7°C, with experiential once-a-month temperatures reaching amid 23.9°C in the August and 26.8°C in the March. Mean yearly rainfall is 2,467.07 mm, and mean once-a-month rainfall of Liberia differs from 27 millimeters in January to approximately 408 millimeters in September. Precipitation happens during the year, with highest precipitation happening from June to September, for the newest climatology, 1991 to 2020 as shown in Figure 3. Although, mentioned in Figure 4 displays the spatial difference of the experiential average yearly rainfall and temperature through Liberia (Pietrzak, et al 2021).



Source:[https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB\\_Liberia%20Country%20Profile-WEB%20%281%29.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf)

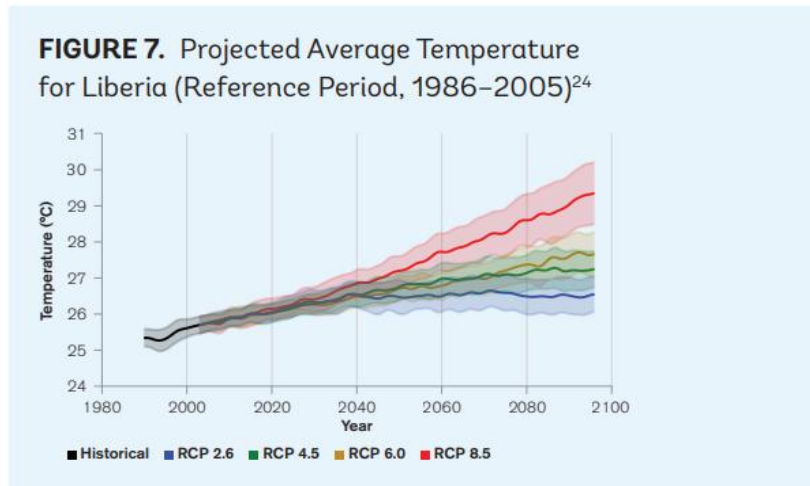


**FIGURE 4.** Map of Average Annual Temperature (°C) (left); Annual Precipitation (mm) (right) of Liberia, 1991–2020<sup>17</sup>



Source:[https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB\\_Liberia%20Country%20Profile-WEB%20%281%29.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf)

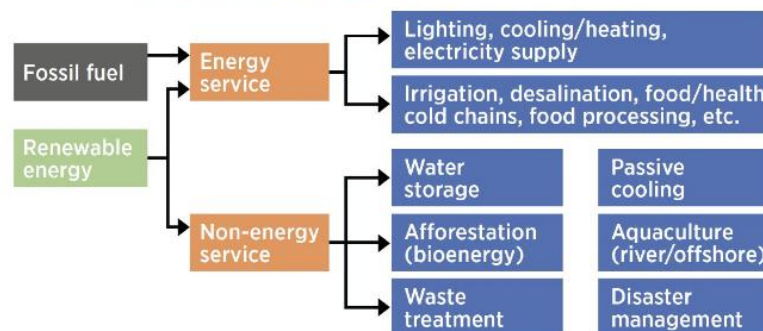
By the finding of the research it has been identified that climate change is expected to upsurge temperatures of Liberia and influence the availability of water through Liberia; few zones may similarly experience flooding because of the augmented concentration of precipitation, coastal destruction and rise in sea-level. Although Liberia is at extraordinary danger to expected climate trends of augmented temperatures, high inconsistency of rainfall with probable augmented substantial precipitation happenings. Below a high-release situation, forecasts display a probable upsurge of once-a-month temperatures of 3.2°C for 2080s, with a likely upsurge of additional than 4.8°C through the completion of the period (Wesseh, et al 2020). Although, mean yearly temperatures for Liberia are projected to rise, warming degrees are projected to be upper and maximum quick in the northern internal areas of Liberia as contrasting to coastal areas of Liberia. Below a great release situation, it is expected that hot times will happen in 24 percent to 65 percent of all days by mid-century and by 29 percent to 90 percent of all days by the completion of the era. Record quick upsurge will be in July, August and September, yet the hot period of the year is predictable to start before and last late. Hot nights are similarly projected to upsurge through 37 percent to 89 percent and 49 percent 95 percent of entirely nights for middle and completion of the era, correspondingly 0.23 Temperature increase, as revealed in Figure 7, are expected to upsurge from corner to corner entirely release situations all over the finish of the era. Augmented heat and life-threatening heat circumstances will have important implications for the public health and animal health, environments, and agriculture (Rehman, et al 2019).



Source: [https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB\\_Liberia%20Country%20Profile-WEB%20%281%29.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15917-WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf)

Finding of the research has shown that numerous climate change adaptation approaches need substantial energy utilisation, however the character of consistent, reasonable, and contemporary RE facilities in climate adaptation is not extensively recognised in strategy making. By as long as ‘greener infrastructure’ for the greatest climate susceptible nations or subdivisions, RE unlocks adaptation ways that similarly endorse extenuation and strengthen adaptation exertions in supplementary subdivisions synchronously (Woiceshyn and Daellenbach, 2018). From now, renewables are essential to be combined into policymaking and development procedures of adaptation plans. It has been founded that there is a theoretical relations among RE and climate change adaptation by exemplifying the chance RE delivers for elegant, actual, and complete climate adaptation, along with the assistances of renewables-based adaptation, prominence some of the assistances of sanitary energy changes to climate change adaptation (Seward, 2021).

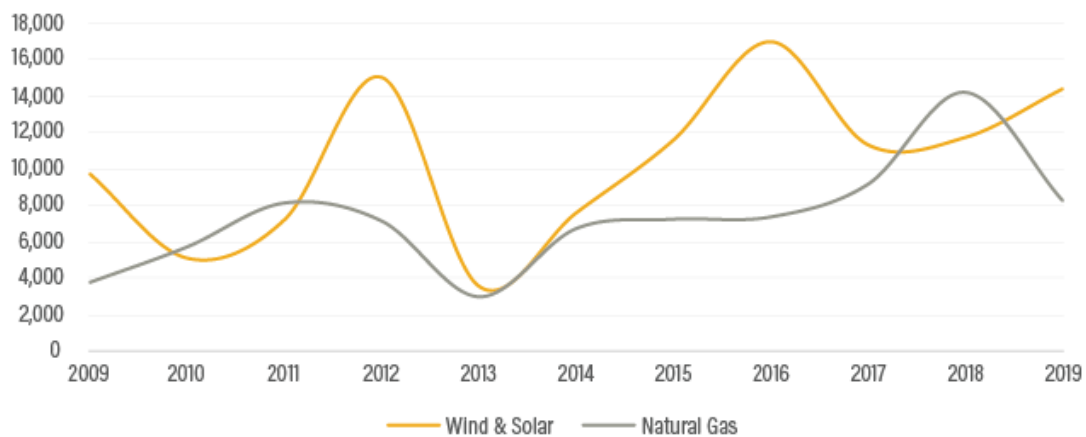
**Figure 6:** Multifunctional aspects of renewable energy contribution to climate change adaptation



Source: <https://www.irena.org/publications/2021/Aug/Bracing-for-climate-impact-2021>

The finding displays that wind and solar smallholdings have conquered innovative power plant constructs in Liberia in current ages, whereas remnant fuel plants predominantly the plants which need coal fired to be run endure to be superannuated at best ever speed. In the year 2019, solar 5.3 GW and wind 9.1GW signified 62 percent of entirely fresh producing capability, paralleled to 8.3 GW of natural gas, whereas 14 GW of coal-fired extent was superannuated. It is also expected that the utmost fresh electrical generation added in Liberia in the year 2020 could originate from solar and wind, along with various fresh natural gas plants expected to signify less than a part of fresh generating capacity. Indeed, few of these connections may be overdue by the COVID-19 pandemic (Saint, et al 2019).

### Annual Capacity Additions of Natural Gas vs Wind & Solar (in Megawatts)



Source: EIA.  
2005.22

 WORLD RESOURCES INSTITUTE

Source: <https://www.wri.org/insights/setting-record-straight-about-renewable-energy>

## CONCLUSION AND RECOMMENDATION

### CONCLUSION

It has been concluded by the researcher that Liberia is going towards destruction. The climate in Liberia is becoming worse day by day. Temperature is increasing day by day in Liberia and will increase more by 2050. Although, these changes reproduce the understanding that human anxiety of the climate is essentially permanent, for many eras at minimum. Various plants and animals are responding to the variation of climate in actions that are dependable with the apparent heating with concerns all over managed and natural environments. Other

perceptible impacts of climate change in Liberia are intensified the different type of diseases among the Liberia's public, injury of various animals and plants biodiversity, destruction and lesser lifespan of use of infrastructure and public facilities initiated by the flooding, upsurge in the level of ocean and overflow of swamp land, shortened the sources of renewable energy (RE) and injury of capability of chiefly the society which is linked with farming sector of Liberia. Moreover, the process and the strategy document of climate variation has been prepared by Liberia's government in order to ensure that climate change reformed copy and mitigation issues are being acknowledged at government level and in sectoral growth exertions and main cross sectoral. Nowadays the CIF approved the funding of around 23.25 million dollars to help in the transforming the renewable energy sector of Liberia. The present idea drives at developing approximately 9.8 MW hydropower plant at the destination of Gbedin and that will fall in the Mano River in the Nimba region and bring a cheap, consistent and appropriate source of electric energy to the country. Although, the recommendations are provided by the researcher which includes "Promoting RE to encounter climate change" and "Increase the Price of Carbon ". Carbon emissions are becoming the main reason behind the climate change in Liberia and to avoid the influences of climate change the government of Liberia has to increase the price of carbon so the government can control the carbon emission in the country. Also the government has to transform their energy production to the RE which could save Liberia from the impacts of climate change and the worst condition which is now in Liberia.

## **RECOMMENDATIONS**

### **Promoting RE to encounter the climate change**

Liberia has experienced noteworthy change in the climate in the recent past, and the impacts of the climate change is predicted to be more accelerated in the future. The properties of climate change are varied, and comprise precipitation variations, life-threatening temperature, droughts, floods and fires. Conservatory gasses (CS), like CO<sub>2</sub>, ozone and methane, are supposed to speed up climate variation and aggravate the properties of climate change (Yu, et al 2021). An important part of Conservatory gasses emissions are formed by conservative electrical energy methods, which are habitually centered on oil, coal and natural gas. However, the government of Liberia must have to convert the energy generating procedure to the RE system. Because RE methods fully depend on solar, wind and hydroelectric energy have arisen as widely held energy substitutes in the world determinations for climate change (TEPO TOGBA, 2020).

### Increase the Price of Carbon

Increasing the price of Carbon is the recommendation to the government of Liberia. Although, the pricing method of carbon like; releases trading methods which cover releases or the levies on carbon which charge each ton direct an enduring indication to organisations by making an inducement to decrease polluting actions and to invest the capitals in RE selections and low-carbon invention. The goal of the Liberian government should be to increase the price of carbon because CO<sub>2</sub> is the most horrible enemy of the climate of Liberia (Zhou, et al 2021). It is directly released when coal, oil and other remnant petroleum are blackened for generating the electrical energy. Moreover, the energy people utilise in Liberia to power their homes, smartphones and cars. Through the minimum utilisation, people of Liberia can control their own participation in climate change (Wang, et al 2018).

### REFERENCES

1. Acheampong, A.O., Dzator, J. and Savage, D.A., Renewable energy, CO<sub>2</sub> emissions and economic growth in sub-Saharan Africa: Does institutional quality matter?. *Journal of Policy Modeling*, 2021; 43(5): 1070-1093.
2. Adams, S. and Acheampong, A.O., Reducing carbon emissions: the role of renewable energy and democracy. *Journal of Cleaner Production*, 2019; 240: 118245.
3. Argyrou, M.C., Christodoulides, P. and Kalogirou, S.A., Energy storage for electricity generation and related processes: Technologies appraisal and grid scale applications. *Renewable and Sustainable Energy Reviews*, 2018; 94: 804-821.
4. Arifin, S.R.M., Ethical considerations in qualitative study. *International Journal of Care Scholars*, 2018; 1(2): 30-33.
5. Azadi, Y., Yazdanpanah, M. and Mahmoudi, H., Understanding smallholder farmers' adaptation behaviors through climate change beliefs, risk perception, trust, and psychological distance: Evidence from wheat growers in Iran. *Journal of environmental management*, 2019; 250: 109456.
6. Basias, N. and Pollalis, Y., Quantitative and qualitative research in business & technology: Justifying a suitable research methodology. *Review of Integrative Business and Economics Research*, 2018; 7: 91-105.
7. Batel, S., Research on the social acceptance of renewable energy technologies: Past, present and future. *Energy Research & Social Science*, 2020; 68: 101544.

8. Brockway, P.E., Owen, A., Brand-Correa, L.I. and Hardt, L., Estimation of global final-stage energy-return-on-investment for fossil fuels with comparison to renewable energy sources. *Nature Energy*, 2019; 4(7): 612-621.
9. Bromley-Trujillo, R. and Poe, J., The importance of salience: public opinion and state policy action on climate change. *Journal of Public Policy*, 2020; 40(2): 280-304.
10. Bunte, J.B., Desai, H., Gbala, K., Parks, B. and Runfola, D.M., Natural resource sector FDI, government policy, and economic growth: Quasi-experimental evidence from Liberia. *World development*, 2018; 107: 151-162.
11. Cantarero, M.M.V., Of renewable energy, energy democracy, and sustainable development: A roadmap to accelerate the energy transition in developing countries. *Energy Research & Social Science*, 2020; 70: 101716.
12. Chang, S.E., Chen, Y.C. and Lu, M.F., Supply chain re-engineering using blockchain technology: A case of smart contract based tracking process. *Technological Forecasting and Social Change*, 2019; 144: 1-11.
13. Chowdhury, J.I., Hu, Y., Haltas, I., Balta-Ozkan, N. and Varga, L., Reducing industrial energy demand in the UK: A review of energy efficiency technologies and energy saving potential in selected sectors. *Renewable and Sustainable Energy Reviews*, 2018; 94: 1153-1178.
14. Chu, H.Y.S., 2021. *Social Resilience to Flooding: The Implications of Scale* (Master's thesis, University of Waterloo).
15. Dufo-López, R., Bernal-Agustín, J.L. and Vera, Y.E.G., 2019. Energy Management in Microgrids with Renewable Energy Sources: A Literature Review. *Applied Sciences*.
16. Ebhota, W.S. and Jen, T.C., Fossil fuels environmental challenges and the role of solar photovoltaic technology advances in fast tracking hybrid renewable energy systems. *International Journal of Precision Engineering and Manufacturing-Green Technology*, 2020; 7(1): 97-117.
17. Egli, F., Steffen, B. and Schmidt, T.S., A dynamic analysis of financing conditions for renewable energy technologies. *Nature Energy*, 2018; 3(12): 1084-1092.
18. Fashina, A.A., Akiyode, O.O. and Sanni, D.M., The status quo of rural and renewable energy development in Liberia: Policy and Implementation. *SPC Journal of Energy*, 2018; 1(1): 9-20.
19. Gbatu, A.P., Wang, Z., Wesseh, P.K. and Sesay, V.A., How do energy consumption, output, energy price, and population growth correlate with CO2 emissions in Liberia?. *International Journal of Global Environmental Issues*, 2019; 18(3): 209-235.

20. Halperin, A. and Walton, P., The importance of place in communicating climate change to different facets of the American public. *Weather, Climate, and Society*, 2018; 10(2): 291-305.
21. Hou, P., Wu, S., McCarty, J.L. and Gao, Y., Sensitivity of atmospheric aerosol scavenging to precipitation intensity and frequency in the context of global climate change. *Atmospheric Chemistry and Physics*, 2018; 18(11): 8173-8182.
22. Killer, M., Farrokhsersht, M. and Paterakis, N.G., Implementation of large-scale Li-ion battery energy storage systems within the EMEA region. *Applied energy*, 2020; 260: 114166.
23. Kim, K.B., Three essays on applied microeconometrics, 2021.
24. Lin, B. and Ankrah, I., Renewable energy (electricity) development in Ghana: Observations, concerns, substitution possibilities, and implications for the economy. *Journal of cleaner production*, 2019; 233: 1396-1409.
25. Macusi, E.D., Macusi, E.S., Jimenez, L.A. and Catam-isan, J.P., Climate change vulnerability and perceived impacts on small-scale fisheries in eastern Mindanao. *Ocean & Coastal Management*, 2020; 189: 105143.
26. Martins, F.S., da Cunha, J.A.C. and Serra, F.A.R., Secondary data in research—uses and opportunities. *PODIUM sport, leisure and tourism review*, 2018; 7(3).
27. Perera, A.T.D., Nik, V.M., Chen, D., Scartezzini, J.L. and Hong, T., Quantifying the impacts of climate change and extreme climate events on energy systems. *Nature Energy*, 2020; 5(2): 150-159.
28. Pietrzak, M.B., Igliński, B., Kujawski, W. and Iwański, P., Energy transition in Poland—assessment of the renewable energy sector. *Energies*, 2021; 14(8): 2046.
29. Rehman, A., Rauf, A., Ahmad, M., Chandio, A.A. and Deyuan, Z., The effect of carbon dioxide emission and the consumption of electrical energy, fossil fuel energy, and renewable energy, on economic performance: evidence from Pakistan. *Environmental Science and Pollution Research*, 2019; 26(21): 21760-21773.
30. Saint Akadiri, S., Alola, A.A., Akadiri, A.C. and Alola, U.V., Renewable energy consumption in EU-28 countries: policy toward pollution mitigation and economic sustainability. *Energy Policy*, 2019; 132: 803-810.
31. Seward, D.M., Case Study on Value Chain Analysis of Natural Resource Exports in Liberia. *Journal of Service Science and Management*, 2021; 14(6): 597-626.
32. Smith, B., Modeling Energy Flows in Floating In-pond Raceways Utilising Solar Power Back-up., 2021.

33. TEPO TOGBA, A., *Technology-economic Analysis of Hybrid Energy Systems for Rural Electrification in Liberia* (Master's thesis, PAUWES), 2020.
34. Verma, A.K., Influence of climate change on balanced ecosystem, biodiversity and sustainable development: An overview. *International Journal of Biological Innovations*, 2021; 3(2).
35. Wang, B., Wang, Q., Wei, Y.M. and Li, Z.P., Role of renewable energy in China's energy security and climate change mitigation: An index decomposition analysis. *Renewable and sustainable energy reviews*, 2018; 90: 187-194.
36. Wesseh Jr, P.K. and Lin, B., Does improved environmental quality prevent a growing economy?. *Journal of Cleaner Production*, 2020; 246: 118996.
37. Woiceshyn, J. and Daellenbach, U., Evaluating inductive vs deductive research in management studies: Implications for authors, editors, and reviewers. *Qualitative Research in Organisations and Management: An International Journal*, 2018.
38. Yu, M., Wang, K. and Vredenburg, H., Insights into low-carbon hydrogen production methods: Green, blue and aqua hydrogen. *International Journal of Hydrogen Energy*, 2021; 46(41): 21261-21273.
39. Zhou, D., Ding, H., Wang, Q. and Su, B., Literature review on renewable energy development and China's roadmap. *Frontiers of Engineering Management*, 2021; 8(2): 212-222.