Review Article

A REVIEW OF ENERGY DEMANDS AND ITS' IMPLICATION ON CLIMATE CHANGE IN AFRICA

ABSTRACT

Climate change is one of the most pressing issues facing the world today. Communities around the world are already feeling its effects, and the situation is only expected to get worse in the future. One of the sectors particularly vulnerable to climate change's effects is the energy sector. In many African countries, the energy sector is heavily reliant on fossil fuels. This makes these countries particularly susceptible to the effects of climate change, as the availability of fossil fuels is expected to decrease in the future because of climate change. This could lead to higher energy prices and a decrease in the availability of energy. In addition, climate change is expected to have a significant impact on hydropower, which is another important source of energy in many African countries. Changes in rainfall patterns could lead to lower river levels and reduced hydroelectric power generation. This could have a severe impact on the availability of energy in these countries. The effects of climate change on the energy sector are likely to have a knock-on effect on the wider economy. Higher energy prices could lead to inflation, and a decrease in the availability of energy could lead to blackouts and a decrease in production. This could have a devastating impact on the economies of African countries. The effects of climate change on the energy sector are likely to be very damaging for African countries. These countries need to take action to mitigate the effects of climate change and to adapt their energy systems to cope with the changes that are expected to occur. This essay outlines the climate change impacts onthe energy sector in African countries and recommendations to mitigate the effects of these impacts.

Keywords: climate change, energy, fossil fuel, carbon IV oxide emission, Africa.

1. Introduction

Energy continues to be a major driver of economic growth. It is essential for accomplishing sustainable development goals. Energy is required for higher living standards, increased productivity, effective transportation of commodities to the place of demand, and as inputs to a wide range of economic production activities for socioeconomic development to occur (Akpan & Akpan, 2012). The amount of energy used has increased steadily over time. Over the last three centuries, civilization has been more reliant on the usage of fossil fuels (coal, oil, and gas) for industrialization and urbanization (Letcher, 2013). Energy is used most among four economic

sectors: buildings (residential & tertiary), agriculture, transportation, and industry as shown in Figure 1.

Nevertheless, many nations' exploitation of energy to drive their growth processes comes with a growing cost in terms of pollution (Godsday et al., 2023a). The most major environmental problem in the previous decade is the influence on global change in weather, often known as climate change or the greenhouse effect (Azlina& Mustapha, 2012). According to the National Aeronautics and Space Administration (NASA) of USA, defined climate change as a broad range of global phenomena created predominantly by burning fossil fuels, which add heat-trapping gases to Earth's atmosphere (Azlina& Mustapha, 2012). These phenomena include the increased temperature trends described by global warming, but also encompass changes such as sea-level rise; ice mass loss in Greenland, Antarctica, the Arctic, and mountain glaciers worldwide; shifts in flower/plant blooming; and extreme weather events." Many researchers relate the fundamental cause of climate change to human activities associated with rapid global economic expansion, such as human use of various energy sources, rapid deforestation, and bush burning. Greenhouse impacts from emissions of environmental pollutants such as carbon monoxide, hydrocarbon compounds, sulfur oxides, nitrogen oxides, methane, and particulates are assessed because of energy consumption combustion (Godsday et al., 2023b). Amongst several pollutants causing climate change, a great deal of attention has been given to carbon IV oxide emission as the major factor in climate change (Letcher, 2013).

Africa will be the continent hardest hit by climate change because it faces more severe climatic effects than other regions, its economies rely on climate-dependent sectors such as agriculture, and its capacities to cope and adapt are generally limited. The World Bank estimates that Africa's average annual temperature is likely to rise an additional 3-4 degrees by 2099. According to the Intergovernmental Panel on Climate Change, by 2020, 75 to 250 million people across sub-Saharan Africa could face water shortages, and rainfed agriculture could contract by 50% in some African countries. Africa is the world's second-largest, and second-most-populous continent, after Asia in both cases. At about 30.3 million km2 (11.7 million square miles) including adjacent islands, it covers 6% of Earth's total surface area and 20% of its land area. With 1.3 billion people as of 2018, it accounts for about 16% of the world's human population. Africa's population is the youngest among all the continents; the median age in 2012 was 19.7, while the worldwide median age was 30.4. Despite a wide range of natural resources, Africa is the least wealthy continent per capita, in part due to geographic impediments, legacies of European colonization in Africa and the Cold War, predatory/neocolonialistic activities by Western nations and China, and undemocratic rule and deleterious policies (Akpan & Akpan, 2012). Despite this low concentration of wealth, recent economic expansion and the large and young population make Africa an important economic market in the broader global context. Africa is home to much biodiversity; it is the continent with the largest number of megafauna species, as it was least affected by the extinction of the Pleistocene megafauna. However, Africa also is heavily affected by a wide range of environmental issues, including desertification, deforestation,

water scarcity, and other issues (Leach, 1992). These entrenched environmental concerns are expected to worsen as climate change impacts Africa. The UN Intergovernmental Panel on Climate Change has identified Africa as the continent most vulnerable to climate change.

2. Energy in Africa

Africa is the world's second-largest, and second-most-populous continent, after Asia in both cases. It covers about 30.3 million km2 (11.7 million square miles) including adjacent islands. 6% of Earth's total surface area and 20% of its land area. With 1.3 billion people as of 2018, it accounts for about 16% of the world's population. Africa's population is the youngest. Among all the continents, the median age in 2012 was 19.7, while the worldwide median age was 30.4. Despite a wide range of natural resources, Africa is the least wealthy continent per capital, in part due to geographic impediments, legacies of European colonization in Africa and the Cold War, predatory/neo-coloniality activities by Western nations and China, and undemocratic rule and deleterious policies. Despite this low concentration of wealth, recent economic expansion and the large and young population make Africa an important economic market in the broader global context. Africa is home to much biodiversity; it is the continent with the largest number of megafauna species, as it was least affected by the extinction of the Pleistocene megafauna.

However, Africa also is heavily affected by a wide range of environmental issues, including desertification, deforestation, water scarcity, and other issues. These entrenched environmental concerns are expected to worsen as climate change impacts Africa. The UN Intergovernmental Panel on Climate Change has identified Africa as the most vulnerable to climate change. Fossil fuels constitute the main source of electricity generation in Africa as of 2019. Natural gas generated around 334 terawatt hours of electrical energy, while coal was the source of nearly 260 terawatt hours. Among renewable sources, hydropower was the leading source of electricity generation, with an output of 141 terawatt hours. Fig 1 shows electricity generation in Africa as

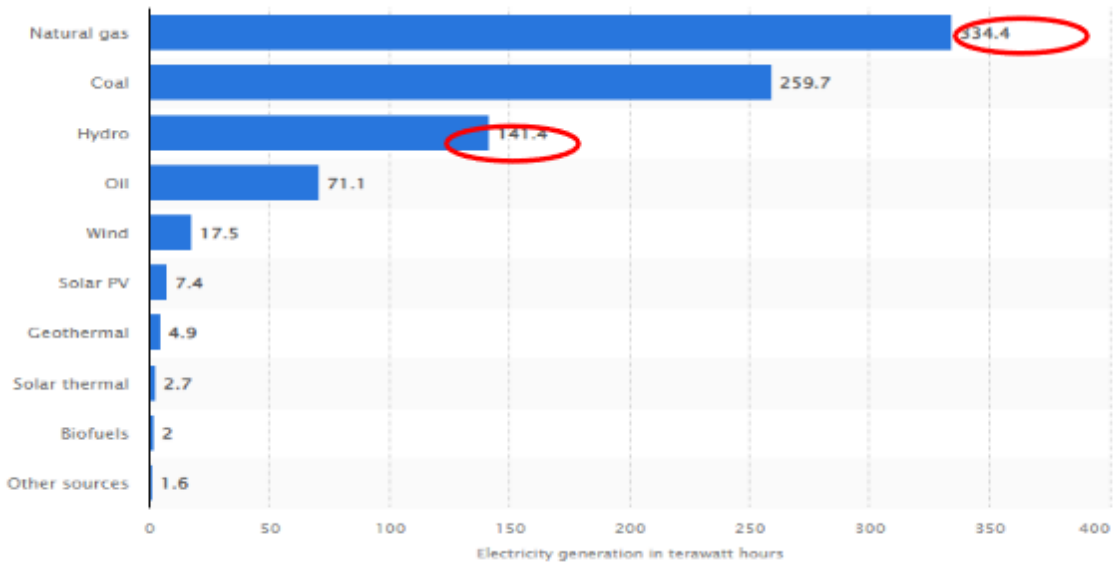

Fig 1: Electricity generation in Africa as of 2019, by source

3. Fossil Fuel Reserves in Africa

Table 1 shows the reserves of fossil fuels and their distribution in Africa. Over 80% and 90% of the oil and natural gas reserves respectively, are found in Northern and Western Africa. Libya accounts for over 70% of the oil reserves in Northern Africa and Algeria accounts for about 55% of the natural gas reserves in the same region. Nigeria accounts for almost all the oil and natural gas reserves in Western Africa (Akpan & Akpan, 2012). In addition, three countries – Libya, Nigeria and Angola – account for about 80% of the proven oil reserves in the continent (EIA, 2011). This distribution of energy resources across the continent becomes more uneven considering South Africa accounts for about 95% of the coal reserves in the continent (EIA, 2011). The industrial and transport sectors are the biggest consumers of fossil fuels in Africa as shown in fig 2.

The industrial sector accounts for about 55% of the coal and natural gas consumed while the transport sector accounts for over 60% of the crude oil consumption in the region. In terms of electricity, fossil fuels account for about 82% of the total electricity generation, mostly dominated by coal (41%) and natural gas (28%)

Table 1: Fossil fuel reserves in Africa

Energy type	Reserves	Regional Distribution
Crude oil	132.1 billion barrels	Northern Africa: 53.2% Western Africa: 28.2%

Natural gas	14.7 trillion m^3	Central Africa: 16.9% Other Africa: 1.7% Northern Africa: 55.8% Western Africa: 36.1% Other Africa: 8.2%
Coal	31,696 billion tones	Southern Africa: 95.2% Eastern Africa: 1.6% Other Africa: 3.2%

Source: BP (2011)

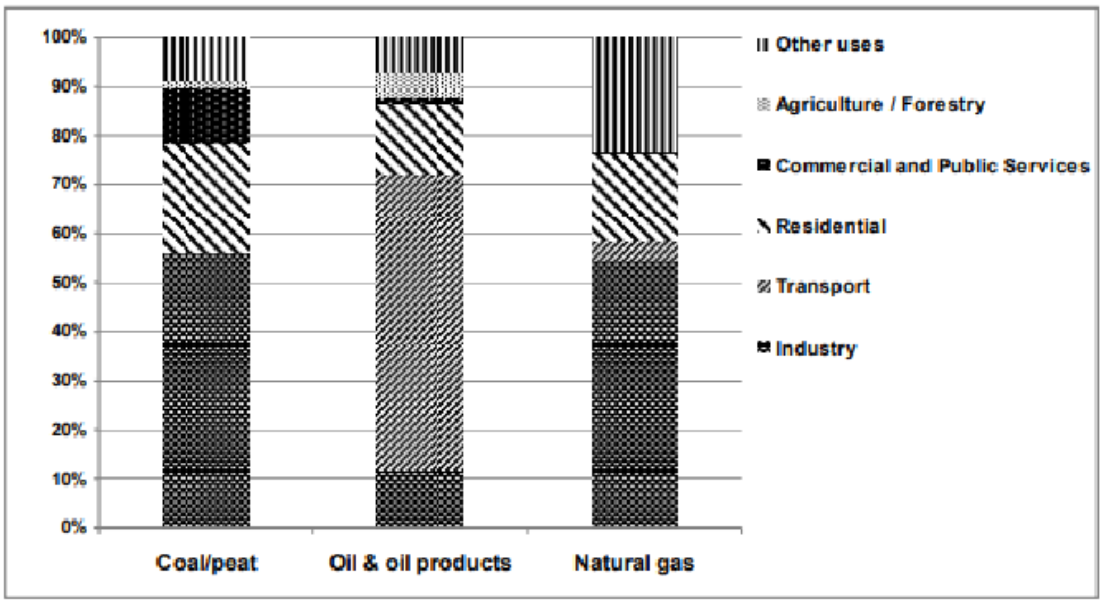

Fig 2: Sectoral Consumption of Fossil Fuels

4. The Role of Fossil Fuels in Green House Gas (GHG) Emissions

Africa emits relatively low amounts of GHG emissions in comparison to other regions and it has very low CO_2 emissions per capital. Africa accounted for about 3.7% of the global CO_2 emissions from the consumption of energy in 2009 (EIA, 2011). The total CO_2 emissions increased by 26% from 2000 – 2009, reaching about 1.12 billion tonnes of CO_2 in 2009. Much of this increase is attributed to a combination of higher GDP growth across the continent, largely driven by the construction and industrial sectors (Heffron, 2021). This trend is not unique to Africa. GDP growth and increased energy consumption have often followed parallel trajectories in developments across Europe, North America and more recently in Asia. In terms of the source of CO_2 emissions, consumption of petroleum accounted for the most (40%), followed by coal,

natural gas, and gas flaring at 35%, 18.4%, and 6.3%, respectively. A small number of countries in Africa are largely responsible for the African emissions. Six countries – Algeria, Egypt, Libya, Morocco, Nigeria and South Africa accounted for over 70% of the CO_2 emissions from the consumption of petroleum while Algeria and Egypt also accounted for about 71% of the CO_2emissions from the consumption of natural gas in 2009 (Akpan & Akpan, 2012). South Africa accounted for over 92% of the CO_2 emissions from coal consumption, that same year. Africa also accounted for about 31% of the global CO_2 emissions from gas flaring; Nigeria accounted for about 36% and 11.4% of the CO_2 emissions from gas flaring in Africa and the World, respectively (EIA, 2011).

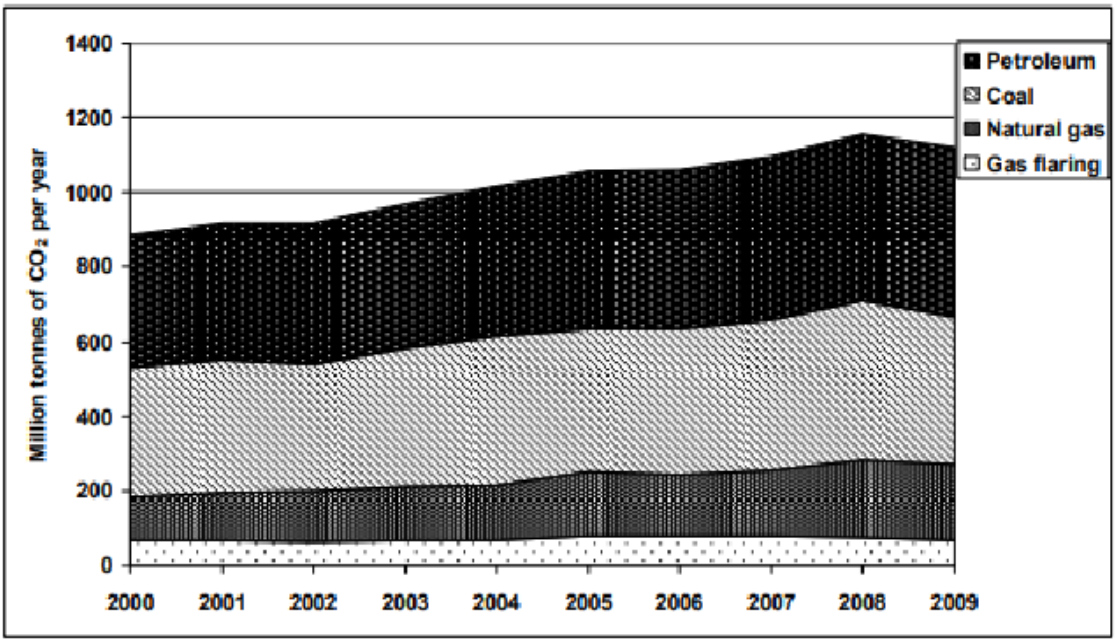

Fig 3: Carbon IV oxide emissions from the consumption of fossil fuels in Africa.

5. Population and Energy Demands

Just 6% of total electricity is consumed by rural households, compared to 73% by urban households, and firewood is a very important source of energy in rural areas. Currently, the country is not producing enough energy to meet demand and it covers the deficit through electricity imports (Azlina& Mustapha, 2012). In rural areas, there are immense challenges facing attempts to extend the national grid. Energy deficits are high in rural areas with an estimated 19% of the rural people only having access to reliable electricity. Without electricity, farmers cannot process their crops, add value, or diversify their livelihoods thereby affecting agricultural productivity. In schools and homes, children struggle to study without light and are cut off from modern technology thus affecting education performance (Takama et al., 2012). Health institutions

are also not spared from intermittent power cuts, and this affects the national health delivery system. Most urban families use electricity for cooking, heating, and lighting, but due to the erratic supply, many households have turned to fuel wood as a supplementary source. Those who can afford it use liquefied petroleum gas, solar systems, or generators using petrol or diesel. Zimbabwe's road, rail, and air transport runs on petroleum derivatives. Imported petrol is blended with ethanol produced by a bio-fuel plant attached to the main sugar refinery in Chiredzi. The plant also generates electricity to run its operations and to supply the local community. The blending of ethanol with petrol contributes to reducing Zimbabwe's greenhouse gas emissions from imported liquid fuels. Zimbabwe's national renewable energy policy is instructive. It addresses climate change concerns and the country's commitment to the world to reduce greenhouse gas emissions. But it also aims to help turn the country into an upper-middle-income economy. It assumes that economic growth will support technological innovations that solve energy poverty. Secondly, growth-oriented national policies are of little relevance to the energy poor. Increased production of renewable energy, thanks to technological advancement, doesn't change anything about distribution. For example, even if additional energy production capacity was added to the national grid through renewables, questions remain about whether access to it would be equitable and affordable. In addition, access and affordability depend on the effectiveness of the power utility, the Zimbabwe Electricity Supply Authority. Regrettably, issues of corruption, rent-seeking, and brain drain at the power utility haven't helped matters. Pinning hope on "modern" energy as the solution for Zimbabwe is overly simplistic. Other factors play a bigger role in shifting consumption patterns (Takama et al., 2012). These include electricity connections and household priorities: profoundly political and social factors. Sustainable developmental goal 7 fails to fully recognize the sensitivity of context. Thirdly, at a global level, it seems the problem isn't about the production and generation of energy, but of inequality. Any technology can be co-opted and perverted by capital. Global finance to developing countries in support of clean and renewable energy had risen to US$21.3 billion in 2017. But these investments don't always aim to ensure universal energy access; they aim for high returns over short time frames.

6. Implication ofEnergy Demand on Climate Change

Climate change is already affecting the energy sector in Nigeria. For example, changes in precipitation patterns are affecting hydropower generation, while higher temperatures are affecting thermal power generation. In the future, climate change is expected to cause even more disruptions to Nigeria's energy sector (Heffron, 2021). For example, sea level rise could damage coastal power plants, while more extreme weather events could damage infrastructure and disrupt power generation. Climate change is expected to have several impacts on Nigeria's energy sector.

These impacts will be felt in both the short-term and long-term and will have serious implications for the country's economic development. In the short term, climate change is expected to cause disruptions to power generation, as well as damage to infrastructure. In the long term, climate change is expected to exacerbate existing problems in the energy sector and could lead to even more serious disruptions (Takama et al., 2012).

Climate change is already having an impact on the energy sector in Cameroon. For example, hydropower production – which accounts for around 80% of the country's electricity has been affected by changes in rainfall patterns. This has led to increased costs and reduced output from hydropower plants. In the future, climate change is likely to have an even greater impact on the energy sector. Extreme weather events such as floods and droughts are expected to become more frequent and intense, affecting energy infrastructure and operations. This will have knock-on effects on the availability and affordability of energy for households and businesses. Action must be taken to mitigate the effects of climate change on the energy sector. This includes investing in climate-resilient infrastructure and diversifying the energy mix. For example, the use of renewable energy sources such as solar and wind power can help to reduce the sector's reliance on hydropower (Openshaw, 2010). By acting now, Cameroon can safeguard its energy sector against the worst impacts of climate change and ensure a secure and affordable supply of energy for years to come.

The Ethiopian energy sector is highly vulnerable to climate change. The country is heavily reliant on hydropower, which is particularly susceptible to changes in precipitation and temperature.

Climate change is already causing reductions in river flows and water availability in Ethiopia, with a projected decrease of up to 20% by the end of the century. This will have a major impact on the country's ability to generate electricity and meet the growing energy demand. In addition to hydropower, Ethiopia also relies on biomass for energy. Climate change is likely to reduce the productivity of agricultural land, which will in turn reduce the availability of biomass for fuel. This will have a significant impact on the rural population who rely on biomass for cooking and heating. Ethiopia is one of the most vulnerable countries to climate change and its impacts are already being felt. The country must take urgent action to adapt its energy sector to the changing climate (Openshaw, 2010).

Climate change is already having an impact on Botswana's energy sector. Droughts are becoming more frequent and intense, leading to reduced river flows and power generation. In response, Botswana has been investing in thermal power plants to diversify its energy mix. However, these plants are also vulnerable to climate change, as they rely on water for cooling. With rising temperatures and more frequent droughts, the country's energy sector is under increasing strain (Barnes & Floor, 1996).

Botswana can partly provide itself with self-produced energy. The total production of all-electricenergy-producing facilities is 3 billion kWh. That is 69% of the country's usage. The rest of the needed energy is imported from foreign countries. Along with pure consumption theproduction, imports, and exports play an important role. Other energy sources such as natural gas or crude oil are also used.

Climate change is already affecting the energy sector in Ghana. The most visible impact is on hydropower generation, which is highly dependent on rainfall. Decreased rainfall due to climate change has led to lower water levels in reservoirs, resulting in reduced electricity generation (Barnes & Floor, 1996).

This has caused blackouts and power rationing in Ghana. Climate change is also affecting the oil and gas sector in Ghana. Rising sea levels are threatening coastal oil and gas infrastructure, and extreme weather events are disrupting production. These impacts are likely to increase in the future, as climate change continues to affect Ghana. The effects of climate change on the energy sector are likely to have far-reaching consequences for Ghana. The sector is a major contributor to the country's economy, and any disruptions could have a significant impact on economic growth and development (Openshaw, 2010). In addition, the energy sector is critical for meeting Ghana's developmental goals, and any setbacks could jeopardize progress towards these goals. The government of Ghana is aware of the risks posed by climate change to the energy sector and is taking steps to mitigate these risks. For example, the government is investing in renewable energy sources, such as solar and wind power, to diversify the country's energy mix and reduce its reliance on hydropower. The government is also working to improve the resilience of the energy sector to climate change, through measures such as strengthening early warning systems for extreme weather events. Despite these efforts, the effects of climate change on the energy sector are likely to continue to be a major challenge for Ghana in the years ahead.

Climate change is already having an impact on the energy sector in Kenya. The most obvious impact is on hydropower, which is the country's main source of electricity. Changes in rainfall patterns are reducing the amount of water available for hydropower generation, and this is likely to become more pronounced in the future as the climate continues to change. This is likely to lead to higher electricity prices and, potentially, power shortages (Bailis et al., 2015). Other forms of renewable energy, such as solar and wind, are also likely to be affected by climate change. Changes in temperature and rainfall patterns will affect the amount of solar radiation and wind available for power generation. Again, this is likely to lead to higher prices and potential power shortages.

The impact of climate change on the energy sector is likely to be negative, leading to higher prices and potential power shortages. This will have knock-on effects on the Kenyan economy as a whole and could lead to increased poverty and social inequality. It is therefore essential that the Kenyan government takes action to mitigate the effects of climate change, and to adapt the energy sector to the new reality (Takama et al., 2012).

The climate in Lesotho is changing, and this is affecting the energy sector. The mainsource of energy in Lesotho is hydropower, which is generated by the country's rivers. These rivers are fed by rainfall, and as the climate changes, the amount of rainfall is becoming less predictable (Bailis et al., 2015). This is causing problems for the hydropower plants, as they are not able to generate as much electricity as they need to. This is leading to power cuts and blackouts, which are harming the economy. The government is working on plans to diversify the country's energy sources, but in the meantime, climate change is having a real impact on the people of Lesotho.

The climate change is already affecting the energy sector in Liberia. The main source of energy in Liberia is hydropower, which is generated by waterfalls. The waterfalls are fed by rivers, which in turn are fed by rain (Bailis et al., 2015). As the climate changes and the rains become more erratic, the waterfallsbecome less reliable as a source of energy (Usiabulu et al., 2022). This is particularly true in the dry season when the waterfalls are at their lowest. The hydropower plants must rely on backup generators, which are powered by diesel. This is not only more expensive but also generates more pollution. In addition, climate change is affecting the agricultural sector, which is a major source of income for many people in Liberia. The changing rains are making it difficult to predict when the planting and harvesting seasons will be, which makes it difficult for farmers to plan their activities (UNEP/WMO, 2011). The lack of reliable information about the weather also makes it difficult for farmers to get the right seeds and other inputs for their crops. As a result, many farmers are struggling to produce enough food to feed their families. The effects of climate change are already being felt in Liberia and are likely to become more severe in the future. The energy and agricultural sectors are particularly vulnerable to the effects of climate change. If the trend continues, it will hurt the economy and the people of Liberia (Practical Action, 2016).

Climate change is already having an impact on the energy sector in Malawi. The country is highly dependent on hydropower, which is being affected by changes in rainfall patterns. Droughts are becoming more frequent and intense, leading to reduced river flows and lower water levels in reservoirs. This has led to power outages and increased costs for the energy sector. In addition, climate change is expected to increase temperatures and reduce rainfall in Malawi (ESMAP, 2015). This will lead to more evaporation and lower water levels in lakes and rivers. This will further reduce the country’s hydropower potential and increase the need for thermal power generation, which is more expensive. The impacts of climate change are already being felt in the energy sector in Malawi and are expected to become more severe in the future. This will have major implications for the country’s economy and development.

Climate change is already having an impact on the energy sector in Mozambique. The main source of energy in the country is hydropower, which is generated by the Cahora Bassa dam on the Zambezi River. The dam provides about 95% of the country's electricity, but it is now at risk due to climate change (IEA, 2016c). The Zambezi River is highly variable, and its flow is determined by the amount of rainfall in the catchment area. In recent years, there has been less rainfall in thecatchment area, and this has led to lower water levels in the dam. As a result, the

dam has had toreduce its electricity output. The reduced output from the dam has had a knock-on effect on the country's economy. Businesses have had to cut back on production, and this has led to job losses (ESMAP, 2015).

The government has also had to ration electricity, which has led to blackouts and power cuts. Climate change is also having an impact on the country's agriculture (Sola et al., 2016). The main crop in Mozambique is maize, and the yield has been declining in recent years because of climate change. The decline in maize production has led to higher food prices, and this has hit the poorest people in the country the hardest. Climate change is expected to have several other impacts on the energy sector in Mozambique in the future. The reduced flow of the Zambezi River is likely to lead to more frequent and severe droughts, which will put even more pressure on the country's hydropower supply. The impact of climate change on agriculture is also expected to continue, and this will put upward pressure on food prices. The government of Mozambique is aware of the risks posed by climate change, and it is taking steps to try and mitigate the impacts (UN, 2015). The country has signed up to the Paris Agreement, and it is working on many projects to increase its resilience to climate change. However, thecountry is already feeling the effects of climate change, and this is likely to continue in the future (Wang et al., 2021).The Rwandan government has been working hard to mitigate the effects of climate change on the country's energy sector. In recent years, the country has experienced an increase in droughts and floods, which has led to a decrease in hydropower production. The government has responded by investing in renewable energy sources, such as solar and wind power. These investments have helped to offset the effects of climate change on the energy sector and have ensured that Rwanda has a reliable source of energy (Letcher, 2013).

7. Proposal for Energy Transition

The recommendations for energy transition are set based on the main energy of countries. Since the main energy sources vary from country to country the recommendations are not the same for all countries. Table 2summarizes these recommendations country by country.

Table 2: Recommendations for energy transition.

Country	Main Energy Source	Domain	Recommendations
Benin	1. Diesel 2. Petrol 3. Kerosene	Transport	Adapt power engines and LPG instead of petrol and diesel.
		Cooking	Promote the use of LPG stoves to reduce the use of kerosene in rural areas.
		Domestic Electricity	Promote the use of solar energy to reduce the use kerosene in rural areas. Raise the number of hydraulic power generators.
		Industrial	Raise the number of hydraulic

		Electricity	power generators.
Botswana	1. Coal 2. Petrol 3. Diesel	Transport	Adapt power engines and LPG instead of petrol and diesel.
		Cooking	Promote the use of LPG stoves to reduce the use of kerosene in rural areas.
		Domestic Electricity	Promote the use of solar energy to reduce the use kerosene in rural areas. Promote the use of gas power generators to reduce the use petrol in rural areas.
		Industrial Electricity	Raise the number of hydraulic power generators. Promote the use of natural gas power generatorsto reduce the use of coal in rural areas.
Cameroon	1. Diesel 2. Petrol 3. LPG	Transport	Promote gas-poweredengines for cars to reduce the use of petrol consumption.
		Cooking	Raise the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace kerosene. Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators. Promote the use of natural gas power generatorsto reduce the use of coal.
Ethiopia	1. Diesel 2. Petrol 3. Coal	Transport	Promote gas-poweredengines for cars to reduce the use of petrol consumption.
		Cooking	Promotethe use of LPG.
		Domestic Electricity	Promote the use of solar energy. Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators to reduce the use of diesel. Promote the use of natural gas power generatorsto reduce the use of coal.

Ghana	1. Diesel 2. Petrol 3. LPG	Transport	Promote gas-poweredengines for cars to reduce the use of petrol consumption.
		Cooking	Raisethe use of LPG.
		Domestic Electricity	Promote the use of solar energy. Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators to reduce the use of diesel. Promote the use of natural gas power generators to reduce the use coal.
Kenya	1. Diesel 2. Petrol 3. Kerosene	Transport	Raise the use of LPG.
		Cooking	Promote the use of solar energy to replace kerosene.
		Domestic Electricity	Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Promote the use of natural gas power generatorsto reduce the use of coal. Raise the number of hydraulic power generators.
Lesotho	1. Coal 2. Petrol 3. Diesel	Transport	Adapt power engines and use LPG instead of petrol and diesel.
		Cooking	Promote the use of LPG stoves to replace kerosene.
		Domestic Electricity	Promote the use of natural gas power generatorsto reduce the use of coal.
		Industrial Electricity	Raise the number of hydraulic power generators to reduce the use of diesel. Promote the use of natural gas power generators to reduce the use of coal.
Liberia	1. Diesel 2. Petrol 3. LPG	Transport	Promote gas-powered engines for cars to reduce petrol consumption.
		Cooking	Raise the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace kerosene.

			Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators.
			Promote natural gas power generators to move from coal.
Malawi	1. Diesel 2. Petrol 3. Coal	Transport	Promote gas-powered engines for cars to reduce petrol consumption.
		Cooking	Raise the use of LPG.
		Domestic Electricity	Promote the use of solar energy.
			Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators to reduce the use of diesel.
			Promote natural gas power generators to move from coal.
Mali	1. Diesel 2. Petrol 3. Kerosene	Transport	Raise the use of LPG.
		Cooking	Promote the use of solar energy to replace kerosene.
		Domestic Electricity	Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Promote natural gas power generators to move from coal.
			Raise the number of natural gas power generators.
Mozambique	1. Diesel 2. Petrol 3. LPG	Transport	Promote gas-powered engines for cars to reduce petrol consumption.
		Cooking	Raise the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace kerosene.
			Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators.
			Promote natural gas power generators to move from coal.
Nigeria	1. Diesel 2. Petrol	Transport	Promote gas-powered engines for cars to reduce petrol

	3. LPG		consumption.
		Cooking	Raise the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace kerosene. Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators. Promote natural gas power generators to move from coal.
Rwanda	1. Diesel 2. Petrol 3. LPG	Transport	Promote power engines for cars to reduce petrol consumption.
		Cooking	Raise the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace kerosene. Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators. Promote natural gas power generators to move from coal.
Sierra Leone	1. Diesel 2. Petrol	Transport	Promote gas-powered engines for cars to reduce petrol consumption.
		Cooking	Promote the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace petrol. Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators. Promote natural gas power generators to move from diesel.
Morocco	1. Coal 2. Diesel 3. LPG	Transport	Adapt gas-powered engines and use LPG instead of petrol and diesel.
		Cooking	Raise the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace kerosene. Raise the use of gas-powered generators to reduce the use of

			petrol.
		Industrial Electricity	Raise the number of hydraulic power generators. Promote natural gas power generators to move from coal.
South Africa	1. Coal 2. Diesel 3. Petrol	Transport	Adapt gas-powered engines and use LPG instead of petrol and diesel.
		Cooking	Promote the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace kerosene. Promote the use of gas-powered generators to reduce the use of petrol.
		Industrial Electricity	Promote the use of hydraulic power generators to move from coal. Promote natural gas power generators to move from coal.
Swaziland	1. Diesel 2. Petrol	Transport	Promote gas-powered engines for cars to reduce petrol consumption.
		Cooking	Promote the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace petrol. Raise the number of hydraulic power generators to reduce the use of diesel.
		Industrial Electricity	Raise the number of hydraulic power generators. Promote natural gas power generators to move from diesel.
Uganda	1. Diesel 2. Petrol 3. Kerosene	Transport	Adapt gas-powered engines and use LPG instead of petrol and diesel.
		Cooking	Promote the use of LPG stoves to reduce the use of kerosene in rural areas.
		Domestic Electricity	Promote the use of solar energy to replace kerosene in rural areas. Raise the number of hydraulic power generators.
		Industrial Electricity	Raise the number of hydraulic power generators.

Zambia	1. Coal 2. Diesel 3. Petrol	Transport	Adapt gas-powered engines and use LPG instead of petrol and diesel.
		Cooking	Promote the use of LPG stoves to reduce the use of kerosene.
		Domestic Electricity	Promote the use of solar energy to replace kerosene. Promote the use of gas-powered generators to reduce the use of petrol.
		Industrial Electricity	Raise the number of hydraulic power generators. Promote natural gas power generators to move from coal.
Zimbabwe	4. Coal 5. Diesel 6. Petrol	Transport	Adapt gas-powered engines and use LPG instead of petrol and diesel.
		Cooking	Promote the use of LPG.
		Domestic Electricity	Promote the use of solar energy to replace kerosene. Promote the use of gas power generators to reduce the use of petrol.
		Industrial Electricity	Promote the use of hydraulic power generators to move from coal. Promote natural gas power generators to move from coal.

8. Conclusion

Access to affordable, reliable and sustainable energy is a fundamental development challenge in sub-Saharan Africa. Civilization has been more reliant on the usage of fossil fuels (coal, oil, and gas) for industrialization and urbanization. Moreso, two-thirds of the population lacks electricity access while 80% rely significantly on traditional biomass. Lack of energy access also negatively impacts economic productivity and income-earning opportunities for small enterprises. African countries are struggling to expand access to energy, and thus the supply of energy, at the same time as they must reduce emissions and adapt to a changing climate. Many African countries embraced the Paris Agreement and are pursuing Nationally Determined Contributions (NDCs) that include significant climate mitigation measures.

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