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Critical Analysis of the Future of Energy Sectors in Sub-Saharan Africa: The Just Energy Transitions in Cameroon, Ghana, and Nigeria

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ABSTRACT

This study investigated the value of renewable energy as a supplementary source to supply Africa's energy needs. For the most part, fossil fuels are used to generate most of the electricity in African nations. Still, renewable energy can unquestionably be added to this to fulfil the national need and the growing concern about climate change on a worldwide scale. Among the top African nations, Cameroon, Ghana, and Nigeria are all by nature gifted with an abundance of renewable energy resources that have the potential to increase their respective energy generation capacities, thereby fostering industrialization, reducing global warming, and generating green jobs. These countries have a plethora of renewable energy resources, but they have not yet reached the full potential of those resources. They consequently do not contribute as much to the production of electricity as they could nationwide. The primary problems with renewable energy in African countries are the enforcement of current legislation, insufficient infrastructure, unbalanced policy, excessive pricing for renewable energy, and lack of enthusiasm for renewable energy. The current study looks at how rules and policies made by the government may ensure a supply of sustainable energy when they are made with awareness and the support of the stakeholders. The study's findings support the idea that using renewable energy to generate electricity can greatly reduce greenhouse gas emissions. Subsidizing the tax on renewable resources can also encourage energy production, creating jobs.

This study tries to give a standardized way to practice adaptation techniques to climate change to efficient, clean, safe, and cost-effective energy and renewable energy consumption within the northern city of Garoua, Cameroon. The main research goals are to (1) examine how climate change will affect the energy sector, (2) evaluate how Garoua will implement climate adaptation in the city using the law and policy tools identified in the study, and (3) pinpoint any gaps and difficulties that have arisen so far in the use of these tools, thereby providing some key recommendations. These goals are achieved by employing a methodological approach that included both the analysis of primary data collected through interviews with pertinent stakeholders to determine whether governments are prepared to implement climate change laws and policies for the energy sector, as well as secondary data, such as laws and policy documents, to assess how Law and Policy tools are applied. These resources include programs for energy transition and climate litigation, as well as analyses of the institutional frameworks of the cities of Cameroon. More recommendations are put forth to develop a future legal and regulatory framework that is better suited to this global issue.

Keywords: Climate change, law and governance, implementation, energy sector, renewable energy, energy communities, Sub-Saharan African countries

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LIST OF ABBREVIATIONS

AEDC………......Abuja Electricity Distribution Company

AER……………Rural Electrification Agency

AfDB…………..African Development Bank

AIACC………....Assessment of Impacts and Adaptation to Climate Change

ARSEL………...Electricity Sector Regulatory Agency

BEI………….....Baseline Emissions Inventory

BPA……………Bui Power Authority

CAPEX………...Capital Expenditure

CAPP……….....Central African Power Pool

CAR……………Central African Republic

CDM……….......Clean Development Mechanism

CDM PoA……...Clean Development Mechanism Programme of Activities

CER……………Certified Emission Reduction

CO_2 …………….Carbon dioxide

CoM SSA………Covenant of Mayors in Sub-Saharan Africa

COP…………….Conference of Parties

CPP……………..Country Priority Plan

CSOs……………Civil Society Organizations

DRC…………….Democratic Republic of Congo

ECG…………….Electricity Company of Ghana

EDC…………….Electricity Development Corporation

ENEO…………..Cameroon National Electricity Utility

ESDP…………...Energy System Development Plan

FAO…………….Food and Agriculture Organization

FGN…………….Federal Government of Nigeria

FiT……………...Feed-in-Tariff

GDP…………....Gross Domestic Product

GESP…………...Growth and Employment Strategy Paper

GET-FiT………..Global Energy Transfer Feed-in-Tariff

GHG…………...Green House Gas emissions

GIZ…………….Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH

GoC……………Government of Cameroon

GRIDCo……….Ghana Grid Company

GVE……………Green Village Electricity

HSH……………Hydrosolar PV Hybrid

ICLEI Africa….International Council for Local Environmental Initiatives (Local Governments for Sustainability)

IMF……………International Monetary Fund

INDC………....Intended Nationally Determined Contributions

IPCC…………..Intergovernmental Panel on Climate Change

IPP…………....Independent Power Producers

LECs…………..Local Energy Communities

MEA…………..Millennium Ecosystem Assessment

MINEE………..Ministry of Water and Energy Resources

MINEPAT……..Ministry of Economy, Planning, and Regional Development

MINEPDED……Ministry of Environment, Nature Protection and Sustainable Development

MINFI………...Ministry of Finance

MINRESI……..Ministry of Scientific Research and Innovation

NAEC………….Nigeria Atomic Energy Commission

NAP…………....Cameroon's National Adaptation Plan

NDC…………...National Determined Contributions

NEAPRP………National Energy Action Plan for Poverty Reduction

NEDCo………...Northern Electricity Distribution Company

NGN…………...Nigerian Naira

NGOs………….Non-Governmental Organizations

NHPC………….Nachtigal Hydropower Company

NITS…………...National Interconnected Transmission System

NOAA…………National Oceanic and Atmospheric Administration

MDGs………….Millennium Growth Goals

PNACC………..National Adaptation Plan to Climate Change

PNIA…………..National Agricultural Investment Plan

PoA……………Programme of Activities

PPA……………Power Purchase Agreement

PPPs…………...Public Private Partnerships

PSFE II………...Sectoral Programme Forest, and Environment

PURC………….Public Utility Regulatory Commission

PV……………..Photovoltaic Panels

RE……………..Renewable Energy

REDD+………..Reducing Emissions from Deforestation in Developing Countries

REDP………….Renewable Energy Development Programme

REMP…………Rural Electrification Master Plan

REMU………...Renewable Energy Micro-Utility

RESPRO………Renewable Energy Service Program

RESs…………..Renewable Energy Sources & RET…………...Renewable Energy Technology

RVA…………..Risk and Vulnerability Assessment

SDG…………...Sustainable Development Goals

SEACAP……....Sustainable Energy Access and Climate Action Plan

SEA4ALL……..Sustainable Energy for All

SMEs…………Small and Medium Size Enterprises

SNC…………...UN Second National Communication

SONATREL…..National Society of Transport Electricity

SPANB II……...National Biodiversity Strategy and Action Plan

SPIE…………...Sustainable Platform for Integrated Economic Empowerment

SSA……………Sub-Saharan Africa

SWERA………..Solar Wind Energy Resource Assessment

TSO……………Transmission System Operator

T&D…………...Transmission and Distribution

UN…………….United Nations

UNCBD……….United Nations Convention on Biological Diversity

UNCED……….United Nations Conference on Environment and Development

UNDP………....United Nations Development Programme

UNFCCC……...United Nations Framework Convention on Climate Change

USD…………...United States Dollar

VAT…………...Value Added Tax

VRA…………...Volta River Authority

WAPP…………West AFRICA Power Pool

WCED………...World Commission on Environment and Development

XAF…………..Central African Franc

CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

Almost all of Africa's current energy demand cannot be satisfied by the continent's existing per-country energy production. The amount of energy at a nation's disposal is somewhat correlated with its development and industrial expansion (Kihombo et al., 2021).[1] Any nation that is genuinely interested in industrial expansion must have access to electricity. This is true because industrial progress leads to socioeconomic growth, which is what many countries want (Sambo et al., 2012; Kraus et al., 2021; Tutak et al., 2020 & 2021). More than 1.3 billion people in the globe still lack access to reliable power, according to research by Nerini et al.[2] In 2017, fewer than 1 in 10 individuals lacked access to power, according to the 2019 Renewables Energy Global Status Report.[3] 35% of the population is Asian, and 61% are from Sub-Saharan Africa (SSA). Making electricity access universal by the year 2030 is one of the main objectives of the United Nations' Sustainable Energy for All (SE4All) program.[4] To meet their energy needs, nations like China, Germany, India, Brazil, and the United States, etc. have diversified into different renewable and sustainable energy sources (Daniel Sánchez Herranz 2009; Brodny et al., 2021). Solar, wind, biofuels, hydropower, biomass, wave or tidal energy, and geothermal energy are some examples of these renewable sources of energy. The necessity to switch to or diversify into various energy mixes was mentioned by Joubert et al.[5] and Achawangkul et al.,[6] among other factors. The depletion of fossil fuels (coal, natural gas, and oil) and/or a low water table, which are to blame for the decline in dam water levels, are only a few of these changes. They also have a detrimental influence on the ecosystem and may have a severe health impact. African nations must thus investigate this matter immediately and make a deliberate decision that will benefit the entire population that depends on it and be in line with the UN 2030 agenda.According to Asumadu-Sarkodie and Owusu,[7]

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[1] S. Kihombo, Z. Ahmed, S. Chen, T.S. Adebayo, D. Kirikkaleli, Linking financial development, economic growth, and ecological footprint: what is the role of technological innovation? Environ. Sci. Pollut. Res. (2021) 1–11.
[2] F.F. Nerini, O. Broad, D. Mentis, M. Welsch, M. Bazilian, M. Howells, A cost comparison of technology approaches for improving access to electricity services, Energy 95 (2016) 255–265.
[3] AfricaEnergyPortal, Renewables 2019 Global Status Report, 2019 [Accessed Online: 17/03/2023], https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf.
[4] U.N.G. Assembly, Transforming Our World: the 2030 Agenda for Sustainable Development. Resolution Adopted by the General Assembly on 25 September 2015, United Nations, New York, 2015. http://www.un.org/ga/search/view_doc. asp.
[5] E. Joubert, S. Hess, J. Van Niekerk, Large-scale solar water heating in South Africa: status, barriers and recommendations, Renew. Energy 97 (2016) 809–822.
[6] Y. Achawangkul, N. Maruyama, M. Hirota, C. Chaichana, S. Sedpho, T. Sutabutr, Evaluation on environmental impact from the utilization of fossil fuel, electricity and biomass producer gas in the double-chambered crematories, J. Clean. Prod. 134 (2016) 463–468.
[7] S. Asumadu-Sarkodie, P.A. Owusu, Feasibility of biomass heating system in the Middle East technical university, Northern Cyprus campus, Cog Eng 3 (2016) 1134304, https://doi.org/10.1080/23311916.2015.1134304.

global warming is a direct outcome of the negative effects of carbon dioxide (CO_2) emissions, which may cause irreparable harm to the Earth over time. According to reports, the main global causes of CO_2 emissions include the production and use of energy.[8] The Sustainable Development Goal 7 (SDG-7) aim for the year 2030 can only be achieved with the availability of reliable, affordable, and clean energy.[9] The lack of access to electricity in most developing nations, particularly in Africa, is a significant factor in favour of renewable energy (RE). Consider Nigeria, which has seen years of load shedding, inconsistently inadequate energy supply, and power outages.[10] According to Olatomiwa et al.,[11] over 60% of Nigeria's population is not connected to the national grid, therefore they must rely on alternative sources of electricity, such as burning fuelwood or biomass and self-powered generation (diesel/petrol generators). Several African nations frequently experience this situation.

The continual use of fossil fuel-based energy sources, which is now viewed as problematic due to several issues (greenhouse gas emissions, the depletion of fossil fuel reserves, and other environmental concerns),[12] has been caused by the growing global energy demand and the growing population. Additionally, as the authors note, a reliable energy supply is a crucial component of the economy for transportation, lighting, and heating in the home, industrial equipment, and other uses. By substituting renewable energy sources (RESs) for fossil fuels, the production of greenhouse gases is greatly reduced. Olatomiwa et al.'s[13] observation regarding how RE helps to protect the global climate by reducing greenhouse gas emissions was similar. Yet, it is necessary to consider a diversity of RESs because, technically, a single-source RE system is not thought to be stable, particularly for isolated loads in rural or distant places.[14]

To examine the underlying causes of climate change, particularly those that are generated by human activity in the energy sector, this research concentrates on the energy sector. It confirms the claim made by Davidson and Winkler (2003) that improving and expanding industrial production in developing African nations is difficult due to a lack of energy access. While Davidson et al. (2002) and Vuuren (2008) argued that the eradication of poverty has been linked to the energy crisis, Gerup et al (2004) claimed that African leaders should actively create greater space for energy-intensive industry.

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[8] S. Asumadu-Sarkodie, P.A. Owusu, A review of Ghana's energy sector national energy statistics and policy framework, Cog Eng 3 (2016) 1155274, https://doi.org/10.1080/23311916.2016.1155274.

[9] S. Asumadu-Sarkodie, P.A. Owusu, Forecasting Nigeria's energy use by 2030, an econometric approach, Energy Sources B Energy Econ. Plann. 11 (2016) 990–997.

[10] *Ibid.*

[11] L. Olatomiwa, S. Mekhilef, A.S.N. Huda, O.S. Ohunakin, Economic evaluation of hybrid energy systems for rural electrification in six geo-political zones of Nigeria, Renew. Energy 83 (2015) 435–446.

[12] P.A. Owusu, S. Asumadu-Sarkodie, A review of renewable energy sources, sustainability issues and climate change mitigation, Cog Eng 3 (2016) 1167990, https://doi.org/10.1080/23311916.2016.1167990.

[13] L. Olatomiwa, R. Blanchard, S. Mekhilef, D. Akinyele, Hybrid renewable energy supply for rural healthcare facilities: an approach to quality healthcare delivery, Sustain Energy Technol Assess 30 (2018) 121–138.

[14] L.M. Halabi, S. Mekhilef, L. Olatomiwa, J. Hazelton, Performance analysis of hybrid PV/diesel/battery system using HOMER: a case study Sabah, Malaysia, Energy Convers. Manag. 144 (2017) 322–339.

This position is supported by commentators from Africa and those who agree with them. They contend that attempting to only reduce emissions through international emissions legislation would be pointless.

The effectiveness of some important laws and policy instruments utilized in some countries to undertake climate adaptation methods needs to be given additional thought and support at this point. Why is it crucial to assess how effective they are? To determine the level of readiness and capacity of the government to assist in the necessary transformation of the entire economy towards climate resilience. Also, it is crucial to point up achievements made so far with these laws and governance tools in the nation and pinpoint places for progress. Internationally, it offers a framework for contrasting how various nations approach climate governance. Following this assessment, additional recommendations will be made regarding the shortcomings and issues found in using legal and policy tools to address climate change, as well as ways to better implement transformational policies to facilitate the necessary shift toward a climate-resilient city.

Considering this strategy, this thesis will particularly respond to the following:

1.2 Research Question

How effective are laws and governance used in Sub-S African cities to carry out strategies for energy transition and adaptation to climate change?

1.3 Background of the study

To address the study topic, this work will analyze the adaptation techniques being implemented in the Sub-Saharan African nations of Nigeria, and Ghana, with a focus on Cameroon. To evaluate these measures, this study will look at the efficiency of some legal and policy instruments that Cameroon has used over time to achieve climate resilience and an energy transition. It attempts to give both a theoretical and practical framework for assessing a government's readiness to step up climate policy, particularly in the energy sector, and implement critical climate-resilient policies.

The fast-rising climate risk has more obvious effects on cities and the financial situation of local governments, therefore even while the paper makes some allusions to national laws and policies in Cameroon, it also particularly evaluates the local government's readiness. It is quite likely that effective adaptation will improve urban life, protect people and infrastructure, foster community ties, and increase economic output in African nations.

To thoroughly examine the local government's readiness to implement climate change legislation and policies in the energy sectors, I will use the city of Garoua as a case study for the methodology.

Why the Energy Sector?

It is commonly acknowledged that having access to modern, dependable, and efficient energy services is a significant, if not crucial, factor in driving economic growth. However, due to limited access to modern energy services, most African countries struggle to meet their development and social obligations. This situation must change if the continent and its sub-regions are to be economically competitive with other developing regions of the world and achieve their sustainable development goals.

Traditional biomass, which frequently has negative environmental and health effects, is nevertheless used by several African nations to satisfy a significant amount of their domestic energy needs. The region has not seen the amount of investment or governmental commitment needed to support RE and energy-efficient technologies, and neither have they been extensively adopted. In comparison to the resources dedicated to the conventional energy sector, very little money is spent on developing technology for RE and energy-efficient systems.

Why Cameroon, Ghana, and Nigeria?

To begin with, Cameroon is committed to the fight against climate change and has made a balancing act to contribute to global warming. The nation adopted a formal strategy for growth and employment in 2009 with a defined 5-year roadmap of projects and sectoral goals to permanently eradicate underdevelopment. As part of the nation's commitment to the Paris Climate Agreement, investments in the energy industry are essential in helping the country achieve emergence by 2035. The National Climate Change Adaptation Plan offers a framework to direct the coordination and implementation of climate change adaptation measures in Cameroon, and the configuration of the power transmission and distribution network is a topic of debate. This reawakens the discussion about the country's power grid, where experts view decentralisation as the best option to encourage access to contemporary energy services in isolated communities.

Also, it is undeniable that RE can be added to the fossil fuel-based energy sources that make up most of the power generation in African nations to meet local demand and the growing concern about climate change on a global scale. Among the leading African nations, Cameroon, Ghana, and Nigeria are blessed with an abundance of RESs that have the potential to increase their respective energy generation capacities, thereby promoting industrialization, reducing global warming, and creating green jobs. These nations have a wealth of RESs, but they have not completely utilized their possibilities. As a result, they do not contribute as much as they could to the creation of electricity nationwide. The main issues with RE in African nations are a lack of interest in RE, imbalanced policy, enforcement of current regulations, high RE prices, and inadequate infrastructure.

Why Garoua?[15]

The City of Garoua in the North Region of Cameroon is committed to taking climate action, with support from the Covenant of Mayors in Sub-Saharan Africa (CoM SSA). To achieve this, the city is working to complete its Sustainable Energy Access and Climate Action Plan (SEACAP) and has completed its baseline reports. These reports include the Baseline Emissions Inventory (BEI), Risk and Vulnerability Assessment (RVA) and Access to Energy Assessment (energy Profile). The workshop focused on setting up a climate-resilient target for the Environment, Biodiversity and Forests sector to rehabilitate the Bénoué riverbanks, increasing biodiversity and water infiltration, preventing riverbank erosion, and preventing climate hazards. The city is also being developed to target the Water and Health sectors, increasing access to clean water to help reduce the spread of waterborne diseases. GIZ and ICLEI Africa **(GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH and ICLEI Africa - International Council for Local Environmental Initiatives [Local Governments for Sustainability])** have collaborated with the city to host a hybrid 6-day workshop at the end of May 2021 to build on previous work and jointly develop context-specific climate and energy targets and actions for each relevant sector.

1.4 Research Method

The use of empirical qualitative investigations and narrative analysis will be used to add to the analytical discussion of this research. The qualitative data used in the empirical analysis will be acquired using two different methods: (1) Analysis of key legal and policy documents; and (2) interviews with relevant stakeholders. Literature review from pertinent articles and publications in peer-reviewed journals, books, and other sources is also used in the research approach to provide a deeper understanding of the subject matter. The study will employ both primary data (interviews) and secondary data (Case laws, journals, treaties, national reports, government policies, articles, textbooks, news, and websites).

Since national and government-published documents are quality-assured and have a high degree of correctness, this work claims that using primary data will give interviewers a first-hand account of the situation and information, whilst using secondary data will give an accurate analysis of the

[15] Covenant of Mayors in Sub-Saharan Africa; Garoua in Cameroon is making significant headway with its climate action journey with CoM SSA, Published: 7 Sep 2021

legislation and policy concerns in the various countries. The interview will also be analyzed using a thematic coding process, which entails attentively reviewing the data to spot recurring themes and concepts. It will take familiarizing oneself with the data, coding, creating themes from the data obtained, examining themes, defining, and labelling themes, and producing some results to analyze the data gathered from the interviews. Consequently, the methodology approach described below will be used to assess the empirical findings:

- Examining the readiness of different levels of government to adopt laws and regulations for the energy sector related to climate change using primary data obtained through interviews with pertinent stakeholders.
- Using secondary data, such as law and policy papers, to examine how the tools listed below are being applied.

1. Institutional framework tool
2. Local policy development tool
3. Relevant stakeholders' engagement tool
4. Climate Litigation tool
5. Energy Transition projects

1.5 Aims of the study:

The primary goal is to offer a systematic and repeatable process for establishing legislation and regulations that will enable the use of clean, safe, cost-effective, and efficient RESs within the city of Garoua. The following three objectives will be the focus of the research: (1) To investigate how the energy sector might be impacted by climate change activities. (2) To assess the effectiveness of Garoua's implementation plans in the context of the legal and policy frameworks in order to implement climate adaptation in the city. (3) To identify the limitations and challenges currently encountered in using these tools to implement climate adaptation strategies and to make additional recommendations.

The research will provide some sound recommendations for decision-makers and stakeholders on improved ways to implement Garoua's climate adaptation strategy to obtain more successful results for climate adaptation. Also, as a model for other cities as well as in Garoua, the research will be able to provide a scientific framework for assessing the effectiveness of current implementation plans. This study is also expected to be helpful in the future for academic and research purposes as a direction and a reference.

1.6 Outline of the study

Chapter 1 outlines the study’s introductory part, which includes the introduction, research question, research method, and aims of the study.

Chapter 2 evaluates some literature reviews that discuss energy communities, energy transitions in Sub-Saharan Africa and the effects of climate change on the energy sector in Cameroon. Additionally, it will explain some current gaps in the literature and look at how research relates to them.

Much attention is given in **Chapter 3** to the methodology approach employing secondary and primary data. It assesses laws and policies on renewable energy, the local level of climate governance in Cameroon, as well as the degree of application of some laws and tools for policymaking, such as programs for local policy creation, institutional frameworks, stakeholder involvement, climate change mitigation, and energy transition. To learn more about how these tools are being used in the City of Garoua, interviews will also be performed.

The findings from the method employed in Chapter 3 are examined in **Chapter 4**'s analysis. Afterwards, conversations are held, and new suggestions are made for the future. These are directed towards the Cameroonian city of Garoua, but they can serve as a model for other emerging communities as well.

CHAPTER 2

LITERATURE REVIEW

2.1 Energy Communities and Energy Transitions in Sub-Saharan Africa (SSA)

The solar community is gaining popularity worldwide (Awad and Gül, 2018). Research has shown that a sharp drop in the cost of photovoltaic (PV) modules and an increase in photovoltaic efficiency (up to 44.5%) are responsible for this popularity.[16] This shows that photovoltaic modules have great potential to become one of the main components of energy production systems in local energy communities (LECs). A family or an entire community can purchase photovoltaic panels and install them on the roof of a property or building to provide the community with the electricity it needs. Injecting excess generation into the grid or capturing missing energy from the grid requires a billing system (charging PV module owners) and in some cases a connection to the grid power infrastructure.

As stated by Lazdins et al., 2021, energy communities bring together a range of collective energy actions (e.g., generation, distribution, supply, aggregation, consumption, sharing, energy storage, electric vehicles, and provision of energy-related services) and in terms of social welfare (Walker G. and Devine -Wright P. 2008) and a study. [17]

According to a recent study by Lowitzsch J., Hoicka C.E. and Van Tulder F.J. (2020), energy communities may eventually become the norm in energy markets. However, the difficulties of defining, constraining, owning, and managing a distribution network must be considered and carefully considered. There are many other barriers to the successful deployment of PV in local energy communities, such as funding, social acceptance, political support, and rights management structures.

Ambole et al., (2021) argue that access to clean, affordable, and sustainable energy is a prerequisite for creating a low-carbon economy that can sustain resilient communities.[18] By leveraging decentralized RES production and consumption, local communities are now seen as a means of building these low-carbon economies. For this reason, advocates of sustainability narratives are pushing for democratic systems of government that give local communities greater participation and decision-making power in energy production. [19] [20] Energy policy shifts are mainly taking place in the Global

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[16] How Solar Panel Cost and Efficiency Have Changed over Time. Available online: https://news.energysage.com/solar-panel-efficiency-cost-over-time/ (accessed on 13 March 2023).

[17]Energy Communities: An Overview of Energy and Social Innovation. Available online: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC119433/energy_communities_report_final.pdf (accessed on 13 March 2023).

[18] World Bank. *Tracking SDG 7, The Energy Progress Report 2020*; IRENA: Washington DC, USA, 2020. [**Google Scholar**]

[19] *Ibid.*

[20] Sovacool, B.; Sidorstov, R. Energy governance in the United States. In *The Handbook of Global Energy Policy*; John Wiley & Sons, Ltd.: Hoboken, NJ, USA, 2013; pp. 435–456. [**Google Scholar**]

North, especially in Europe, where cities can mobilize resources and engage multiple stakeholders in the use of alternative energy pathways.[21] [22] [23] As the Global North relies heavily on non-renewable energy sources, normative targets to reduce carbon emissions are an important driving force behind these alternative strategies (Van Der Schoor et al., 2016; Moroni S. et al., 2019); Dóci et al.,[24] 2015). However, the energy transition discussion is concurrently supporting a shift to low-carbon economies and expanding energy access for the millions of citizens who lack access to it in the Global South, particularly in SSA. (Farand C. 2020; [25] Newell and Phillips 2016).

Different RE community projects that have drawn significant notice in nations like the United Kingdom, Netherlands, and Germany are characteristic of recent studies on energy communities.[26] [27] For instance, sustainable energy communities own about 22% of Germany's installed renewable electricity potential.[28] Community energy programs have successfully lowered peak consumption charges and utilised economies of scale in Chile.[29] The Netherlands explores and presents energy communities as societal niches that support changes in the energy system.[30] As a result of its predominately top-down policies, the United States is contrasted with European nations as having lagged behind in the development of energy communities.[31] Most often, policies and programs supporting RE that offer incentives and raise public knowledge of collective action are what is behind the developed economies' sharp rise in community energy initiatives.[32] [33] [34] The existence of workable business models, creative financing and compensation plans, clever technologies, societal acceptance, and—most crucially—citizen participation is also related to their success.[35]

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[21] Verbong, G.; Loorbach, D. *Governing the Energy Transition: Reality, Illusion or Necessity?* Routledge: New York, NY, USA, 2012. [**Google Scholar**]
[22] LaBelle, M.; Horwitch, M. The Breakout of Energy Innovation: Accelerating to a New Low Carbon Energy System. In *The Handbook of Global Energy Policy*; Wiley-Blackwell: Chichester, UK, 2013; pp. 113–126. [**Google Scholar**]
[23] Fouquet, R.; Pearson, P.J. Past and Prospective Energy Transitions: Insights from History. *Energy Policy* **2012**, *50*, 1–7. [**Google Scholar**] [**CrossRef**]
[24] Dóci, G.; Vasileiadou, E.; Petersen, A.C. Exploring the transition potential of renewable energy communities. *Futures* **2015**, *66*, 85–95. [**Google Scholar**] [**CrossRef**][**Green Version**]
[25] Farand, C. Campaigners Urge African Union to Stop Fossil Fuel Proliferation on Continent. 2020. More information available online: **https://www.climatechangenews.com/2020/02/10/campaigners-urge-african-union-stop-fossil-fuel-proliferation-continent/#:~:text=In%202018,%20nearly%2070%%20of,energy%20to%20help%20end%20poverty** (accessed on 18 March 2023).
[26] Klein, S.J.; Coffey, S. Building a sustainable energy future, one community at a time. *Renew. Sustain. Energy Rev.* **2016**, *60*, 867–880. [**Google Scholar**] [**CrossRef**][**Green Version**]
[27] Thellufsen, J.Z.; Lund, H. Roles of local and national energy systems in the integration of renewable energy. *Appl. Energy* **2016**, *183*, 419–429. [**Google Scholar**] [**CrossRef**]
[28] Romero-Rubio, C.; Díaz, J.R.D.A. Sustainable energy communities: A study contrasting Spain and Germany. *Energy Policy* **2015**, *85*, 397–409. [**Google Scholar**] [**CrossRef**]
[29] Avilés, C.; Oliva, S.; Watts, D. Single-dwelling and community renewable microgrids: Optimal sizing and energy management for new business models. *Appl. Energy* **2019**, *254*, 113665. [**Google Scholar**] [**CrossRef**]
[30] See footnote 24.
[31] See footnote 26.
[32] See footnote 28.
[33] Walker, G. What are the barriers and incentives for community-owned means of energy production and use? *Energy Policy* **2008**, *36*, 4401–4405. [**Google Scholar**] [**CrossRef**]
[34] Walker, G.; Devine-Wright, P.; Hunter, S.; High, H.; Evans, B. Trust and community: Exploring the meanings, contexts and dynamics of community renewable energy. *Energy Policy* **2010**, *38*, 2655–2663. [**Google Scholar**] [**CrossRef**]
[35] The REScoop Model. Available online: **https://www.rescoop.eu/the-rescoop-model** (accessed on 15 March 2023).

2.2 Climate Change in Cameroon

Although there is doubt in the forecasts regarding the precise amount, rate, and geographical patterns of climate change, it is generally acknowledged that if the right steps are not taken, its effects will have a significant impact on the poor, particularly in emerging nations, and influence the fate of many generations to come (IPCC 2007). Important industries for national growth, like agriculture and the exploitation of natural resources, are already feeling the negative effects of climatic impacts to which, these countries are susceptible (IPCC (2001); Huq et al. (2003); AIACC (2004); Hassan et al. (2005); Reid et al. (2005); UNFCCC (2007) a, b; UNDP (2007); FAO (2008); UNFCCC (2009)). This seriously jeopardizes efforts to reduce poverty and advance national development (Ogunseitan (2003); World Bank (2004); MEA (2005); Stern et al. (2006); Nkem et al. (2007)). The climate in Cameroon has been extremely varied during the past few decades, often with very high amplitudes, like that of the entire continent of Africa (Molua and Lambi (2007); IPCC (2007); IUFRO (2010)). (Hassan (2006); Molua (2008) comments that the climate in Cameroon is already a major factor limiting freshwater availability and crop yields in wide areas, but Annecke (2002); Dixon et al. (2003), Innes and Hickey (2006), Nkem et al. (2007), Asangwe (2002 & 2006), argue that the situation is made worse by land degradation, rapid population growth, slow economic expansion, significant social issues, the spread of illnesses, and overall ecosystem degeneration. These mechanisms are heavily interrelated and are substantially affected by climate change. Unprecedented efforts based on findings from the ecological, social, economic, political, and health sciences are required to stop this catastrophic spiral of severely deteriorating social, economic, and natural situations. To solve the urgent issue, decision-making processes that are supported and founded on a complete understanding of all associated processes are essential.

2.3 The Cameroon Legal System and Climate Change

Cameroon is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and is committed to the fight against climate change. The World Commission on Environment and Development (WCED) in the framework of the Brundtland Report (1987) and the Stop Growth Report of the Club of Rome (1972) highlighted the degradation of the environment both at the global and regional level in connection with human activities, particularly economic activity. The UNFCCC was adopted by Cameroon in 1994 and the ratification of this Convention and efforts made to comply with its provisions as described in a Second National Communication (SNC)[36] demonstrate

[36] https://unfccc.int/sites/default/files/resource/cmrnc2.pdf. Published in September 2015.

Cameroon's willingness to contribute effectively to the global effort to combat global warming. The resulting climatic disturbances, such as droughts, frequent floods, violent winds, heat waves, landslides, rising sea levels, etc., are already occurring more frequently in several regions of the world, affecting more and more people. The 1972 drought and especially the 1983-1984 drought were considered among the most severe that affected agroecological zones of the country (PNACC, 2015).

The Paris Agreement seeks to ensure a significant reduction in GHG emissions with respect to the 2035 baseline scenario. Cameroon formally ratified this agreement in July 2016 with an NDC of a 20% reduction in GHG emissions with respect to the 2035 baseline scenario (Alfonso et al., 2019). At COP21, Cameroon committed to this new climate regime by presenting its INDC at COP21 with the ambition of reducing 25% of its GHG emissions with respect to the 2035 baseline scenario. The NDC of Cameroon made provisions for a number of guidelines, such as a requirement for regular audits in large energy-intensive industries; the establishment of building codes on thermal standards of construction and renovation and certification process; the creation of economic and incentive frameworks to promote and remove barriers for investments in renewable energy; sustainable management of wood energy, better stoves, and the promotion of biogas; frequent mandatory energy audits in large energy-intensive businesses; support the development of "smart grids" in rural regions; and fostering connections with the West Africa Power Pool (WAPP) and the Central African Power Pool (CAPP); the three national grids (North, South, and East) should be connected, and the development plan should be in line with REDD + (Ademola et al., 2017).

Due to a lack of appropriate corporate strategies, Cameroon did not profit from the Clean Development Mechanism (CDM) of the Kyoto Protocol. Renewable energy has been highlighted as a strategy to help Cameroon achieve its NDC, mitigate climate change, and get access to affordable, dependable, and clean energy with a 25% share of the energy mix (Lianbiao Cui and Yuran Huang, 2018).

Key Laws and Regulations	Description
Cameroon Vision 2035 (2009)	This document presents Cameroon's overall policy direction in pursuit of development. General objectives are: reducing poverty to minimal levels; becoming a middle-income country; becoming a newly industrialised country; consolidating democracy and enhancing national unity. It was prepared by the Ministry of Economy, Planning and Regional Development.
LAW N° 2011/022 Governing the Electricity Sector in Cameroon (2011)	The law concerns the electricity sector and is focused on ensuring its modernization and development.
Presidential Decree No. 2009/410 establishing the creation, organization	This Decree established the National Climate Change Observatory (ONACC) as a national legal implementing body of climate change

and functions of the National Observatory on Climate Change (2009)	policies (though not yet in operation as of 2014). The Ministry of Environment, Nature Protection and Sustainable Development (MINEPDED) are responsible for the supervision of the ONACC, and overall coordination of climate change activities and policies within the country. It is supervised by the Ministry of Finance for financial matters.
Decree N0 2011/2582/PM setting out how to protect the atmosphere (2011)	This decree establishes the modalities of how Cameroon protects the atmosphere from a list of air pollutants including carbon dioxide, methane and CFCs.[37]
National Biodiversity Strategy and Action Plan (SPANB II), (2012)	This document sets Cameroon's strategy to protect biodiversity. It notably defines adaptation objectives.
National Adaptation Plan to Climate Change (PNACC), (2015)	This is Cameroon's National Adaptation Plan (NAP).
Prime Ministerial Decree No.103/CAB/PM regarding the creation, organization and operation of the Steering Committee for activities to reduce emissions from deforestation, degradation, sustainable management and conservation of forests, REDD+, (2012)	This Decree established the Steering Committee for REDD+. The Committee is headed by the Ministry of Environment, Nature Protection and Sustainable Development (MINEPDED).[38]
National Development Strategy 2020-2030 for structural transformation and inclusive development, (2020)	This document sets the country's development vision for 2030[39].
Decree No. 079/CAB/PM, (2017)	According to Cameroun's second National Determined Contributions (NDC), art. 2 of this document states that the mission of the interministerial committee is to "coordinate and monitor sectoral diligence relating to the implementation of the recommendations of the Paris Agreement on global warming".

Table 1: Overview of general key legislations to address climate change in Cameroon at the national level.[40]

[37] It establishes that the air quality measurement and control stations designed to ensure compliance with the requirements set out in Article 21 of Law No. 96/12 of 5 August 1996 on a framework law for the management of the environment are in sites where pollution is presumed to exceed the limit values. It further lists all industrial activities susceptible to emitting one of the air pollutants.

[38] The Committee is responsible for formulating proposals for REDD+ strategy options, providing feedback regarding the implementation of the strategies, developing selection criteria for REDD+ projects, evaluating REDD+ pilot project proposals, promoting REDD+ activities and validating the work of the Technical Secretary. The Technical Secretary is chaired by MINEPDED and assisted by the Minister of Forests and Fauna (MINFOF). Other members include the Focal Point of the UNFCCC and the National Coordinator of REDD+.

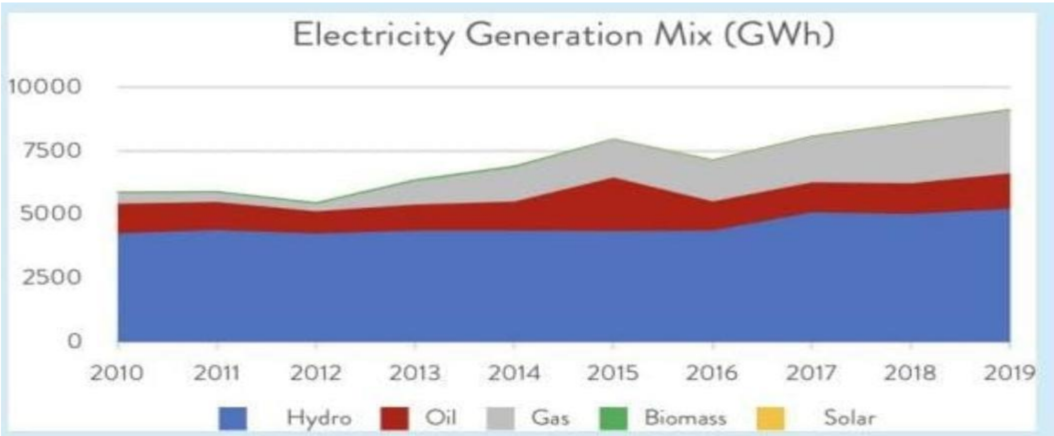
[39] The document notably sets several adaptation measures to be followed. The overall objectives pursued by SND30 are 1) to establish favourable conditions for economic growth and the accumulation of national wealth and to ensure that the structural changes essential for the industrialization of the country are obtained; 2) to improve the living conditions of the populations and their access to basic social services by ensuring a significant reduction in poverty and underemployment; 3) strengthen climate change adaptation and mitigation measures and environmental management to ensure sustainable and inclusive economic growth and social development; and 4) improve governance to strengthen the performance of public action with a view to achieving development objectives.

[40] The Climate change Laws of the World database of the Grantham Research Institute and the Sabin Center available at http://www.lse.ac.uk/GranthamInstitute/climate-change-laws-of-the-world

2.4 An Overview of the Cameroon Energy Sector and How it is Structured to Address Climate Change[41]

Cameroon, also referred to as "Africa in miniature," is geographically diversified and experiences all the continent's major climates, with extreme weather events predicted to become more frequent and intense due to climate change. The country's northern regions are the most vulnerable to climate, followed by coastal areas and the highlands. Climate change is threatening the country's reliance on natural resources and its reliance on agriculture for survival and subsistence. Almost 40% of the nation is covered by tropical forests, making 8 million rural residents more vulnerable to rising levels of poverty and famine. Women are more severely impacted by climate change than males since they make up 75% of workers in the informal agriculture sector and are primarily in charge of their family's welfare and food security.

The industrial sector dominates the nation's electricity consumption, accounting for more than half of the demand for electricity in 2019, (3905 GWh out of the 6998 GWh - source: Enerdata). The other two major consumption sectors are the tertiary sector (1533 GWh) and households (1494 GWh). The latter has been increasing over time as a result of the nation's accelerating demographic growth. Cameroon's population was expected to increase by more than 6 million individuals from 20.3 million in 2010 to 26.6 million in 2020. During that period, their consumption increased by more than 51% at an average annual rate of 4.7%. The aluminium industry leads consumption in the industrial sector with a share of over 45%. The mining and cement sectors come next (especially with the introduction of DANGOTE CEMENT and Cimenterie d'Afrique). Hydroelectricity accounts for 57% of the nation's electricity production (9.149 GWh in 2019), with gas (27%) and oil (15%) following closely behind. Less than 1% of this sum comes from renewable energy sources (RES), which is extremely small. The following graph shows how the distribution of generations has evolved between 2010 and 2019:



[41] Cameroon Country Climate and Development Report 2022.

Figure 1: Recent Evolution of the Generation Mix in Cameroon[42]

2.5 The Current State of Renewable Energy Generation in Cameroon, Ghana, and Nigeria

The current situation of RE for Cameroon, Ghana, and Nigeria is discussed in this section, considering each nation's potential. The potential sources of RE in these nations are determined by their geographical locations. While nations near the equator or in the northern hemisphere would experience high levels of solar radiation, coastal nations would have access to tidal or wave energy. High wind speeds and/or solar radiation are common in dry lands. The countries under consideration are briefly described in Table 2 below.

Country	Population	Land Area (Km^2)	Electricity Generation (MW)	Renewable Energy Generation (MW)
Cameroon	26 545 863	472 710	1402	614.63
Ghana	31 072 940	227 710	4399	1603
Nigeria	206 139 589	910 770	16 384	2079

Table 2: Information on countries under review

2.5.1 The Specific Context of CAMEROON

The continued increase in energy demand in Cameroon, where only 47% of people have access to electricity, creates significant and mounting pressure on its aquatic ecosystems. Cameroon has the third-highest hydropower potential in SSA after the Democratic Republic of Congo (DRC) and Ethiopia (International Hydropower Association 2019). To satisfy 70% of the power need of the country, the Cameroonian authorities have planned for the construction of seven large new dams on the Sanaga River (including the ongoing Nachtigal project, and the Grand Eweng project that has just started). The construction of these dams will significantly change the flow regime and morphological dynamics of the Sanaga River and deeply change ecosystem functioning, with likely major detrimental impacts on biodiversity, especially in the lower section of the river.

Just 20% of the rural and urban population in Cameroon can control power, with the rural population making up between 4% and 6% of this group. (Nemzoue et al., 2020; Guefano et al., 2021)[43] This is the case despite the country's enormous energy potential. Based on theoretical estimation. The

[42] Source: Enerdata

[43] E. Nfah, J. Ngundam, R. Tchinda, Modelling of solar/diesel/battery hybrid power systems for far-north Cameroon, Renew. Energy 32 (2007) 832–844.

various energy potentials of Cameroon include hydro, solar, wind, biomass, tidal, geothermal and gasification.

Despite having a comparatively high level of social and political stability, Abubakar et al.'s paper[44] claim that the lack of a defined RE policy has led to deficits in electricity output. The government and other parties, such as policymakers, must come to a solid decision on how to handle the problem. The situation in Nigeria is similar; the only distinction is that there are policies there, but they only exist on paper.[45] Three important topics, including (i) an overview of the energy situation and standard of living in the region, (ii) how to promote the use of RE, and (iii) policy formulation and recommendation that can bring about good and profitable practices by going the RE route, were covered in a report by Mboumboue and Njomo (2016).[46] The report's conclusion said that fossil fuels and renewable energy can complement one another if they are both used as effectively as possible to produce a lifestyle that will be comfortable for most Cameroonians. Additionally, it was suggested by the authors—and this is also the opinion of many other authors[47] [48]—that it is necessary to raise awareness about the significance of RE and to influence policymaking by decision-makers in a way that will influence intense diversification into alternative renewable and sustainable energy.

Due to Cameroon's potential among SSA nations, which includes having the second-largest biomass potential in the area and having roughly three-quarters of its whole territory (21 million hectares) covered in forest, the country produces most of its energy from biomass.[49] The percentage contributions of each energy source to the overall primary energy production in Cameroon are as follows: Biomass (64.10%), Oil (27.20%), Gas (3.70%), Hydropower (5.00%), and 0% for the others (i.e wind, energy solar and geothermal energy). This means that biomass accounts for most of the energy production, with gas power plants producing the least. Solar radiation is an unexplored RESs in the nation.

To increase the production of energy in Cameroon, several hydropower dams have been constructed on the Sanaga River. The first one was built in the middle section of the river near Edéa in 1954, with a generation capacity of 264 megawatts (MW). The second and the biggest was built at Song Loulou in 1988, 50 km upstream generating 335 MW. The most recent dam was built at Lom Pangar in 2016, on the upper river, generating 30 MW. At the same time, large reservoirs were built at Mbakaou

[44] M.A. Abubakar, A.V. Wirba, J.A. Ardila-Rey, R. Albarracín, F. Muhammad-Sukki, A.J. ´ Duque, N.A. Bani, A.B. Munir, Wind power potentials in Cameroon and Nigeria: lessons from South Africa, Energies 10 (2017) 443.

[45] See footnote 1.

[46] E. Mboumboue, D. Njomo, Potential contribution of renewables to the improvement of living conditions of poor rural households in developing countries: Cameroon′s case study, Renew. Sustain. Energy Rev. 61 (2016) 266–279.

[47] J. Kenfack, O.V. Bossou, E. Tchaptchet, How can we promote renewable energy and energy efficiency in Central Africa? A Cameroon case study, Renew. Sustain. Energy Rev. (2016).

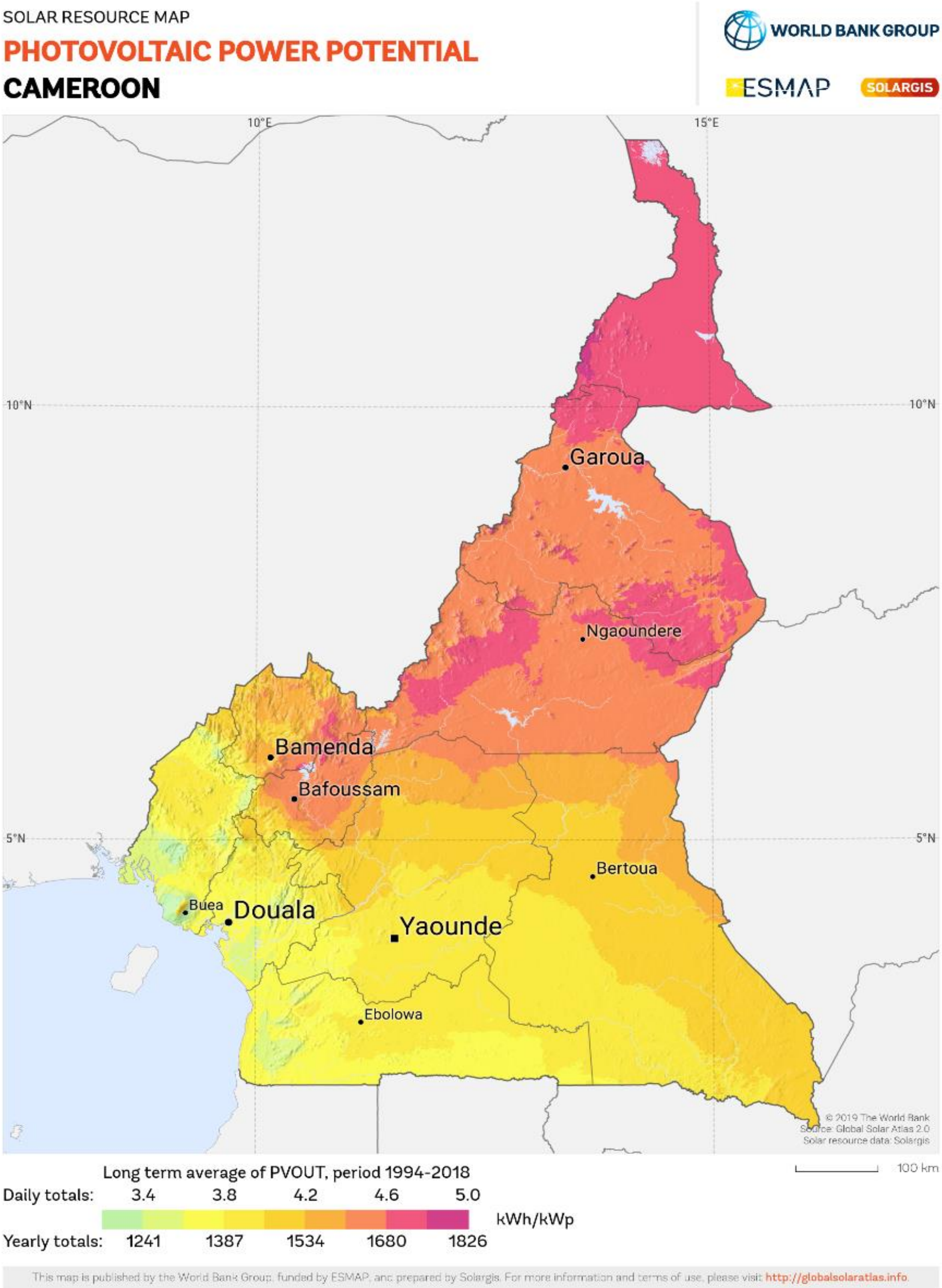
[48] E. Nfah, J. Ngundam, Identification of stakeholders for sustainable renewable energy applications in Cameroon, Renew. Sustain. Energy Rev. 16 (2012) 4661–4666.

[49] See footnote 43.

(1969), Bamendjing (1974) and Mape (1981) for flow regulation, water storage and flood control. The negative impacts of such constructions were numerous. For instance, the Lom Pangar Dam necessitated the clearing of 210 ha of forest land (Banque Africaine de Développement 2011) and the embankment induced modification of soil structure and increased erosion, that in turn increased the turbidity of the river water downstream (Massabé 2016). The impacts of the dams on the aquatic ecosystems could be attributed to changes in connectivity locally and at the catchment scale (Ward and Stanford 1995). In areas of Africa where water temperatures are naturally high, such as Cameroon, for instance, the water temperature increases in reservoirs and promotes eutrophication (Zebaze Togou-et 2011) with reduced oxygen content down-stream (Nyamsi Tchatcho 2018). The alteration to the pattern and timing of flows, the reduction in current velocity and the homogenization of habitat is also likely to have had strong detrimental impacts on biodiversity (Dudgeon et al. 2006), many yet appearing undocumented in the case of the Sanaga River.

Large dams also generally induce forced re-settlement and its subsequent socio-economic impacts. The displacement of the population always results in material losses, under-compensation, and social disruption of local communities. For example, the construction of the Bamendjin Dam in the Sanaga Basin immediately affected over 307,757 people, forcefully displacing about 8,582 inhabitants as 3,178 houses were submerged. The adversely affected population increased over the years, despite the development of rice production and other agricultural activities, such as the growing of corn and groundnuts. Most of the population still lacks clean drinking water, electricity, and agricultural land (Mbih et al. 2014). Moreover, in SSA, dams contribute significantly to malaria risk, particularly in areas of unstable transmission (Kibret et al. 2015), a concern in the context of the water infrastructure of the Sanaga Basin.

Figure 2: Solar energy potentials of Cameroon. Adopted from SolarGIS[50]



According to Figure 2, more than half of the nation's land area has the potential to be used to produce solar energy, particularly in the following regions: Maroua, Garoua, Ngaoundere, Bamenda, Bertoua, and Yaounde.

[50] Solargis, https://solargis.com/maps-and-gis-data/download/cameroon. Accessed online (06/03/2023).

2.5.2 The Context of GHANA

According to data that was made available to the public between 1999 and 2013, Ghana's economy is one of the fastest growing in Africa. Within fourteen years, Ghana reduced poverty by about 28% after moving from a low-income economy to a lower-middle-income economy.[51] [52] Higher electrical energy demand is a result of the impact of economic expansion on the pace of urbanization.[53] [54] This demand is present in both urban and peri-urban areas. Other than hydropower, which produced about 52% of the nation's 2280 MW of electricity in 2012,[55] which is insufficient to meet the country's urgent demand, other energy sources must be investigated. Low rainfall has a huge impact on the current hydropower energy production because it directly affects how well the generating plants operate. Wind and solar energy are two other methods for generating electricity; by 2015, it is planned to produce between 100 and 150 and 12 MW, respectively, from wind energy and solar radiation.[56]

To add the necessary energy to the mix, power generation from a standalone RE source is insufficient. This is because each year, depending on the season and time of year, the sources of these REs change. By delivering the necessary electrical energy around-the-clock, throughout the entire year, Adaramola et al.[57] reported the challenges of the standalone solar energy system. This is because clouds and a lack of sunlight are issues that are related to the power generation process in question. However, there are times when wind speed is insufficient to drive windmill blades, which is when stand-alone wind energy generation from wind experiences downtime. The hybrid system was developed to address the flaw in standalone energy generation systems. Combining two or more energy sources is a component of hybrid energy systems. The systems are interdependent, so even if one fails, the other will continue to function and allow for year-round and 24-hour access to electrical power. This system has been the subject of an investigation by several researchers, and according to the findings that were presented, it was found to be more affordable and dependable than stand-alone systems. (Chen and

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[51] J.T. Mensah, G. Adu, An empirical analysis of household energy choice in Ghana, Renew. Sustain. Energy Rev. 51 (2015) 1402–1411.
[52] M.S. Adaramola, D.A. Quansah, M. Agelin-Chaab, S.S. Paul, Multipurpose renewable energy resources based hybrid energy system for a remote community in northern Ghana, Sustain Energy Technol Assess (2017).
[53] See footnote 51.
[54] S. Gyamfi, M. Modjinou, S. Djordjevic, Improving electricity supply security in Ghana—the potential of renewable energy, Renew. Sustain. Energy Rev. 43 (2015) 1035–1045.
[55] M.S. Adaramola, M. Agelin-Chaab, S.S. Paul, Analysis of hybrid energy systems for application in southern Ghana, Energy Convers. Manag. 88 (2014) 284–295.
[56] Volta River Authority (VRA), Ghana. http://www.vra.com/about_us/profile.php. Online. Accessed: 07/03/2023.
[57] See footnote 55.

Garcia 2016; [58] [59] [60] [61] The usage of this technique is widespread around the world.[62] [63] [64] [65] [66] Figure 3 displays the potential of combining the production of solar and wind energy. The statistics support the claim that independent energy sources might not be able to supply all the electrical energy required at any given time. The variations in the yearly averages of solar radiation and wind energy are depicted in Figures. 3a and 3b.[67]

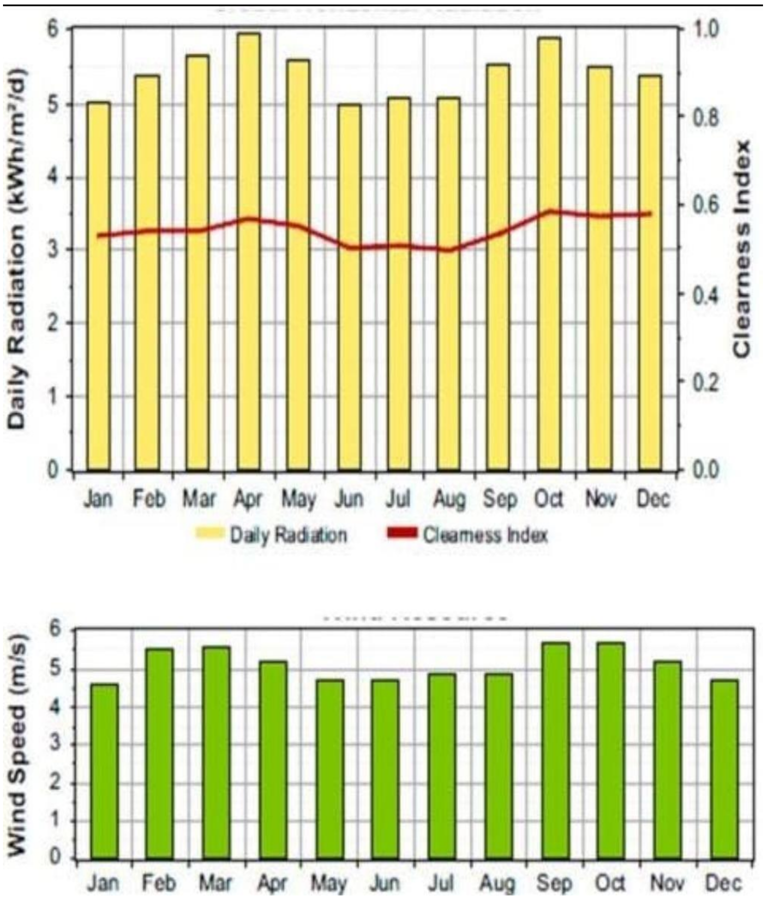

Figure 3: **Potential energy generation in Ghana from:**

a) solar radiation and clearness index &

[58] J. Chen, H.E. Garcia, Economic optimization of operations for hybrid energy systems under variable markets, Appl. Energy 177 (2016) 11–24.
[59] J. Chen, C. Rabiti, Synthetic wind speed scenarios generation for probabilistic analysis of hybrid energy systems, Energy 120 (2017) 507–517.
[60] O.A. Uwaoma, J.N. Emechebe, M. Uthman, O. Oshiga, S. Olisa, The modelling and simulation of 330 KV, 600 MW Shiroro substation in the DIgSILENT environment for integration of hybrid solar PV–hydro system to improve power supply in the federal capital territory (FCT) of Abuja from Shiroro, Nigeria, Europ J Eng Technol Res 6 (2021) 22–29.
[61] P. Nema, R. Nema, S. Rangnekar, A current and future state of art development of hybrid energy system using wind and PV-solar: a review, Renew. Sustain. Energy Rev. 13 (2009) 2096–2103.
[62] F. Caballero, E. Sauma, F. Yanine, Business optimal design of a grid-connected hybrid PV (photovoltaic)-wind energy system without energy storage for an Easter Island's block, Energy 61 (2013) 248–261.
[63] M. Khan, M. Iqbal, Dynamic modelling and simulation of a small wind–fuel cell hybrid energy system, Renew. Energy 30 (2005) 421–439.
[64] A. Yilanci, I. Dincer, H. Ozturk, A review on solar hydrogen/fuel cell hybrid energy systems for stationary applications, Prog. Energy Combust. Sci. 35 (2009) 231–244.
[65] L.-Q. Liu, Z.-X. Wang, The development and application practice of wind–solar energy hybrid generation systems in China, Renew. Sustain. Energy Rev. 13 (2009) 1504–1512.
[66] J. Dekker, M. Nthontho, S. Chowdhury, S. Chowdhury, Economic analysis of PV/ diesel hybrid power systems in different climatic zones of South Africa, Int. J. Electr. Power Energy Syst. 40 (2012) 104–112.
[67] See footnote 55.

b) wind energy. Adapted from Adaramola et al.[68]

After South Africa, Ghana's national power is ranked second in SSA for access rate and fourth overall.[69] [70] As previously mentioned, hydroelectric and thermal power plants produce most of Ghana's electricity. The nation's energy mix also includes other renewable resources. In a report from the AREA conference, held at the Rockefeller Bellagio Centre in Italy,[71] produced by Gyamfi et al.,[72] hardly any effort was made, just like in the year 2012.[73] By 2020, 10% of the nation's total electricity production must come from RESs, according to the government's Renewable Energy Act.[74] According to the source, which is quoted in this contribution, Ghana generates less than 1% of its electrical power from renewable sources as of the time recorded.[75]

One of the most fortunate possibilities for alternative energy sources is wind energy. This is a result of the facility's low construction costs, great efficiency, and potential to help Ghana generate more electricity.[76] According to a measurement made by the Energy Commission,[77] the wind speed in Ghana's Meridian region is between 4.8 and 5.5 m/s at an altitude of 12 m along the East and West of the region. By putting in cutting-edge machinery, the potential of wind energy generation was further realized in 2011. According to the data acquired, it was found that a windmill performs better at higher altitudes.[78]

Biogas is an additional alternative RES that can help Ghana's energy problems. It was found in a study by Mohammed et al.[79] that a biogas plant requires a lot of investment capital. Also, the biogas recovered is best used for cooking rather than for the generation of energy, and because of this, it is predicted that 5 years of operation will be sufficient for the payback. The University of Ghana's 9, 000 m3 biogas plant served as the basis for the evaluation. The reasons why this branch of RE has seen some failures have been the subject of several research, including but not limited to those on economic,

[68] *Ibid.*
[69] See footnote 54.
[70] M. Lugmayr, ECREEE strategy to promote renewable energy and energy efficiency investments in the ECOWAS (2011 to 2016), in SWAC/OECD Meeting: 5-6 December 2011, 2011.
[71] W. Ahiataku-Togobo, Access to sustainable energy in Ghana: role of renewable energy as prerequisite for MDGs, in: AREA Conference at the Rockefeller Bellagio Center, Italy. 22-26, 2012.
[72] See footnote 54.
[73] *Ibid.*
[74] *Ibid.*
[75] E. Commission, Strategic national energy plan 2000-2025 Part 1, in: Energy Review-The Official Journal of the Energy Commission Ghana. November/ December 2004, pp. 17–72.
[76] G.L. Park, A.I. Sch¨ afer, B.S. Richards, Potential of wind-powered renewable energy membrane systems for Ghana, Desalination 248 (2009) 169–176.
[77] See footnote 63.
[78] See footnote 54.
[79] M. Mohammed, I. Egyir, A. Donkor, P. Amoah, S. Nyarko, K. Boateng, C. Ziwu, Feasibility study for biogas integration into waste treatment plants in Ghana, Egyptian J. Petrol. (2016), https://doi.org/10.1016/j.ejpe.2016.10.004.

social, organizational, and technical aspects.[80] [81] [82] There must be regulations and rules in place for any nation to achieve objectives, and they must be properly followed.

The regrettable fact is that while some of these policies, Acts, and/or guidelines have been mentioned in the literature[83] [84] [85] [86] they are frequently not put into practice.[87] The policies for RE in Ghana are shown in Table 3, along with the categories of RE that each policy addressed.

S/N	Renewable Energy Source (RES)	Policy	Target RES	Year
1	Renewable Energy Act	The feed-in tariff, RE purchase obligations, the establishment of RE fund, tax exceptions	RE energy for heat and power	2011
2	National Energy Policy	No specific mention of policy types. Just mentioned energy sector challenges and government objective to overcome such challenges	Covers the whole energy sector including waste to energy, solar, hydropower, geothermal, multiple RE sources, power, bioenergy, biofuels for transport	2010
3	National Electrification Scheme	Research, development, and deployment (RD&D), research program, technology deployment and diffusion, economic instruments, fiscal/ financial incentives, grants, and subsidies	Wind, Onshore, bioenergy, biomass for power, multiple RE sources, power, solar, wind	2007
4	Ghana Energy Development Access Project	Economic instruments, fiscal/financial incentives, loans, economic instruments, fiscal/ financial incentives, grants and subsidies, economic instruments, fiscal/ financial incentives, tax relief	Wind, solar, solar PV	2007
5	Strategic National Energy Plan 2006–2020	Policy support, strategic planning	Multiple RE sources for power, heating	2006

[80] J.F.K. Akinbami, M.O. Ilori, T.O. Oyebisi, I.O. Akinwumi, O. Adeoti, Biogas energy use in Nigeria: current status, future prospects and policy implications, 2001, Renew. Sustain. Energy Rev. 5 (2001) 97–112.
[81] M. Mendola, Agricultural technology adoption and poverty reduction: a propensity-score matching analysis for rural Bangladesh, Food Pol. 32 (2007) 372–393.
[82] S. Feleke, T. Zegeye, Adoption of improved maize varieties in Southern Ethiopia: factors and strategy options, Food Pol. 31 (2006) 442–457.
[83] See footnote 48.
[84] F. Kemausuor, G.Y. Obeng, A. Brew-Hammond, A. Duker, A review of trends, policies and plans for increasing energy access in Ghana, Renew. Sustain. Energy Rev. 15 (2011) 5143–5154.
[85] K. Akom, T. Shongwe, M.K. Joseph, S. Padmanaban, Energy framework and policy direction guidelines: Ghana 2017–2050 perspectives, IEEE Access 8 (2020) 152851–152869.
[86] D. Atsu, E.O. Agyemang, S.A.K. Tsike, Solar electricity development and policy support in Ghana, Renew. Sustain. Energy Rev. 53 (2016) 792–800.
[87] I. Iddrisu, S.C. Bhattacharyya, Ghana′ s bioenergy policy: is 20% biofuel integration achievable by 2030? Renew. Sustain. Energy Rev. 43 (2015) 32–39.

6	Renewable Energy Service Program (RESPRO)	Economic instruments, direct investment, infrastructure investments Solar, Solar PV 1999 Tax, and duty exemptions	Wind, solar, solar PV	1999
7	Tax and Duty Exemptions	Economic instruments, fiscal/ financial incentives, tax relief, economic instruments, fiscal/financial incentives, Taxes	Wind	1998

Table 3: Ghana's policies and strategies for renewable energy. Adapted from Gyamfi et al..[88]

By implementing these regulations, the nation's energy mix will be improved to include more RESs. It is challenging to accomplish the goal for which the policies were designed because of a few obstacles. Table 4 lists some of the obstacles and possible solutions.

S/N	RES	Barrier	Way forward
1	**Solar**	High start-up cost, limited access to information, limited financing schemes, small market	Identify innovative financing mechanisms: soft loans, grants, and flexible financing schemes. Organize awareness campaigns, education and training programs, and workshops
2	**Small hydropower**	Absence of policy framework, lack of information on available resources, lack of financing mechanism, low electricity tariffs	Update the hydro resource map, demonstration projects and extend the grid for rural electrification
3	**Wind**	High start-up cost, limited qualified personnel, low electricity tariff, intermittency	Private sector participation, advanced forecasting, energy management systems (to minimize intermittency)
4	**Biomass**	Water shortages, no promotion policy, financial schemes, high cost, small market, low awareness, competition with the food industry and agriculture about the land use	Support for promotional and training activities (workshops), finalization of feasibility studies and business plans, incentives, and the enforcement of existing environmental laws

Table 4: Barriers and the way forward to renewable energy sources in Ghana. Adapted from Gyamfi et al..[89]

[88] See footnote 54.
[89] *Ibid.*

2.5.3 The Context of NIGERIA

One of the nations with a severe dearth of adequate electricity is Nigeria. With a population of more than 165 million, Nigeria is the most populous country in Africa. Yet, many of its residents live in poverty because most of them earn less than $1 per day.[90] [91] [92]

According to Aliyu et al.,[93] the broader population's extremely limited access to power is to blame for the economy's current lack of appreciable development and maintenance.

Only 40% of the population of the entire nation is said to be connected to the national electricity system, according to a report by Ogundari and Otuyemi.[94] 55.4% of Nigeria's population has access to electricity as of 2020, according to the most recent World Bank data.[95] Hydropower plants located in Kainji, Jebba, and Shiroro in the country's centre provide most of the nation's electrical energy needs. 1360 MW are produced by all the dams, with the Kainji dam producing the most at 760 MW.[96] [97] In comparison to the country's needs, this sum is insufficient. Nigeria produced and used roughly 29.35 and 24.72 billion kWh in 201,[98] respectively. Due to a mutually beneficial agreement, Nigeria sells some of the power it produces to its neighbours, including Niger. There is a need to take use of different kinds of energy generation that are practicable or possible in the country for the country to satisfy its energy needs and equitably supply to other neighbouring countries.[99] [100] [101]

Coal, natural gas, oil, and other fossil fuel energy sources are abundant in Nigeria.[102] More than 90% of the nation's total income comes from these energy sources, which have made a significant contribution to the economic development of the nation.[103] In Nigeria, electrical energy generation was

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[90] A. Iwayemi, Nigeria's dual energy problems: policy issues and challenges, Int Assoc Energy Econ (2008) 17–21.
[91] Internet-World-Statistics-I, Population of Nigeria, Internet World Statistics, 2011.
[92] O. Nanka-Bruce, The Socio-Economic Drivers of Rural Electrification in Sub-Saharan Africa, Surrey Energy Economics Centre (SEEC), School of Economics, University of Surrey, 2010.
[93] A.S. Aliyu, A.T. Ramli, M.A. Saleh, Nigeria electricity crisis: power generation capacity expansion and environmental ramifications, Energy 61 (2013) 354–367.
[94] I.O. Ogundari, F.A. Otuyemi, Project planning and control analysis for suburban photovoltaic alternative electric power supply in Southwestern Nigeria, African J Sci Technol Inno Develop 13 (2021) 31–49.
[95] TheWorldBank, Access to Electricity (% of Population) - Nigeria, 2020 (Accessed Online: 13/03/2023), https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?end=2020&locations=NG&start=1990&view=chart.
[96] Globalenergy, 2017.
[97] AFDB, 2016. Access online (13/03/2023), https://www.afdb.org/sites/default/files/documents/environmental-and-social-assessments/nigeria_-_kainji_and_jebba_hydro_power_plant_rehabilitation_project_-_esia_summary.pdf.
[98] 2020 CIA World Factbook and other sources. (Accessed Online: 09/03/2023) https://theodora.com/wfbcurrent/nigeria/nigeria_energy.html.
[99] S.O. Oyedepo, Towards achieving energy for sustainable development in Nigeria, Renew. Sustain. Energy Rev. 34 (2014) 255–272.
[100] N. Babakatcha, J.A. Yabagi, M.B. Ladan, M.D. Oladipupo, Harnessing solar energy potential as an alternative source of electrical energy in north central, Nigeria, African J Environ Natur Sci Res 3 (2020) 86–94.
[101] Z.A. Elum, V. Mjimba, Potential and challenges of renewable energy development in promoting a green economy in Nigeria, Afr. Rev. 12 (2020) 172–191.
[102] M. Shaaban, J. Petinrin, Renewable energy potentials in Nigeria: meeting rural energy needs, Renew. Sustain. Energy Rev. 29 (2014) 72–84.
[103] See footnote 41.

first made available to the public in 1896; fossil fuel was the primary energy source. Nigeria currently has a population of 165 million people and a landmass of 924000 square kilometres, respectively.[104 105] This necessitates the use of an alternate energy source as well as efficient use of the available land. The energy sector's overreliance on petroleum is what has led to the pandemic supply of electricity.[106 107 108] This overreliance has resulted from a failure to advance RESs that could increase energy production. The potential for RESs in Nigeria has been demonstrated in several studies, with particular emphasis on hydropower,[109 110] solar energy,[111 112] wind energy,[113 114] and bioenergy.[115 116] Except for hydropower, RE had little to no impact on Nigeria's overall percentages of the major energy mixes in 2001, as seen in Figure 4a.

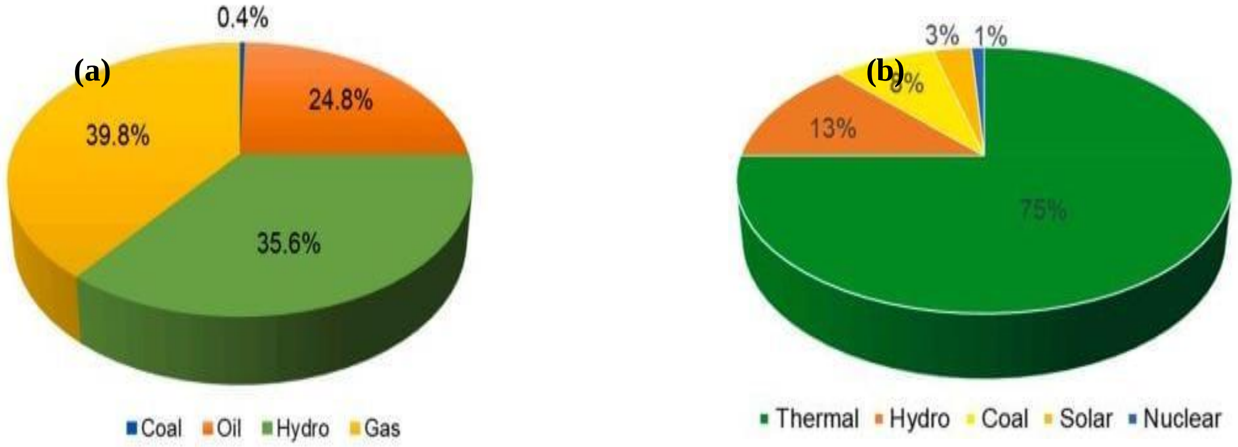

Figure 4: (a) Nigeria's Energy Generation in 2001, (b) in 2014. Both were adapted from Kennedy-Darling et al.,[117 118] respectively.

[104] See footnote 102.
[105] A.V. Wirba, A.A. Mas' Ud, F. Muhammad-Sukki, S. Ahmad, R.M. Tahar, R. A. Rahim, A.B. Munir, M.E. Karim, Renewable energy potentials in Cameroon: prospects and challenges, Renew. Energy 76 (2015) 560–565.
[106] See footnote 102.
[107] A. Sambo, Alternative generation and renewable energy, in: 2nd Power Business Leaders Summit, Ibom Gulf Resort, Akwa Ibom State 12th–14th December, 2007.
[108] J. Kennedy-Darling, N. Hoyt, K. Murao, A. Ross, The Energy Crisis of Nigeria: an Overview and Implications for the Future, The University of Chicago, Chicago, 2008.
[109] K. Owebor, E.O. Diemuodeke, T.A. Briggs, M. Imran, Power situation and renewable energy potentials in Nigeria–a case for integrated multi-generation technology, Renew. Energy 177 (2021) 773–796.
[110] O.A. Fasipe, O.C. Izinyon, J.O. Ehiorobo, Hydropower potential assessment using spatial technology and hydrological modelling in Nigeria river basin, Renew. Energy 178 (2021) 960–976.
[111] H.O. Njoku, O.M. Omeke, Potentials and financial viability of solar photovoltaic power generation in Nigeria for greenhouse gas emissions mitigation, Clean Technol. Environ. Policy 22 (2020) 481–492.
[112] N.E. Chiemelu, O.C. Anejionu, R.I. Ndukwu, F.I. Okeke, Assessing the potentials of large-scale generation of solar energy in eastern Nigeria with geospatial technologies, Scientific African (2021), e00771.
[113] M.S. Adaramola, O.M. Oyewola, O.S. Ohunakin, O.O. Akinnawonu, Performance evaluation of wind turbines for energy generation in Niger Delta, Nigeria, Sustain Energy Technol Assess 6 (2014) 75–85.
[114] R.B. Mshelia, Assessment of renewable energy potentials of the northeast geopolitical region of Nigeria, Renew Ener Sourc Ener Policy Ener Manag 2 (2021) 24–38.
[115] S.O. Jekayinfa, J.I. Orisaleye, R. Pecenka, An assessment of potential resources for biomass energy in Nigeria, Resources 9 (2020) 92.
[116] O.O. Afolabi, S.A. Leonard, E.N. Osei, K.B. Blay, Country-level assessment of agrifood waste and enabling environment for sustainable utilisation for bioenergy in Nigeria, J. Environ. Manag. 294 (2021) 112929.
[117] See footnote 108.
[118] https://www.nigeriaelectricityhub.com/2014/04/01/energy-mix/. (Accessed Online: 09/03/2023).

In May 2015, 3114 MW of energy were produced overall, according to Usman et al.[119] This information can be found in a report from Nigeria's Ministry of Electricity. Gas-fired power plants currently provide more electrical energy than any other source, with hydropower plants producing the second most. Gas makes up 72% of the total contribution compared to hydro's 28%.[120]

Figure 5 shows how much electricity is expected to be produced using various energy blends. The graph shows that natural gas will continue to outperform other forms of power generation. The intriguing thing is that the mix of energy sources for electricity would have included large contributions from renewable energy sources as they would have gained increasing importance. According to the predicted plan for Nigeria for the year 2030, RESs will generate 68 345 MW of the total 190 000 MW as shown in Table 5. Cameroon, Ghana, and other nations in Africa have all embraced RESs. In certain respects, some of these nations appear to be performing better than Nigeria. The most prevalent RESs in these nations, which have attracted a lot of interest, are solar energy, hydropower, wind energy, and biomass. The ability to fully utilize the potential of wave and tidal energy is still far away for African nations.

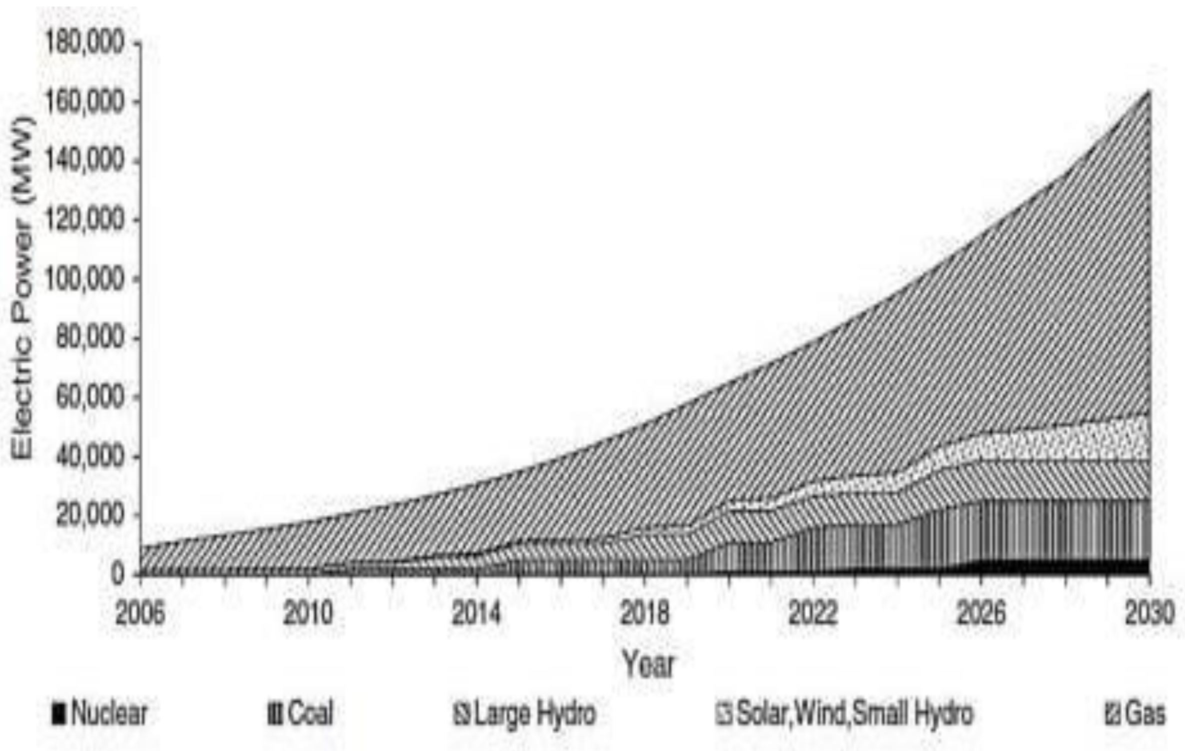

Figure 5: Projected electricity generation from the various energy mix. Adapted from Ibitoye and Adenikinju.[121]

[119] Z.G. Usman, S. Abbasoglu, N.T. Ersoy, M. Fahrioglu, Transforming the Nigerian power sector for sustainable development, 2015, Energy Pol. 87 (2015) 429–437.
[120] *Ibid.*
[121] F.I. Ibitoye, A. Adenikinju, Future demand for electricity in Nigeria, Appl. Energy 84 (2007) 492–504.

Table 5: Projected energy mix in Nigeria by the year 2030. Adapted from Mohammed et al.[122]

Energy sources	2008	2015	2030
Large hydro	1930	5930	48 000
Small hydro	100	743	19 000
Solar PV	5	120	500
Solar thermal	-	1	5
Biomass	-	100	800
Wind	1	20	40
Total RESs	2036	6905	68 345
Total energy sources (including both conventional and RESs)	**15 000**	**30 000**	**1900**

2.6 Adaptation Policy Metrics Anticipating the Effects of Climate Change in SSA Countries

The past COVID-19 pandemic and climate change were inextricably linked, which led to increased pressure for authorities to act quickly on both fronts and fiscal stimulus was being planned to aid in the pandemic's recovery. Sub-Saharan Africa is the most susceptible to climate change, with natural disasters becoming more frequent and intense, such as cyclones Idai and Kenneth, locust outbreaks, droughts, desertification, as well as rising sea levels. Despite economic growth, structural limitations on countries' capacity to respond to shocks and recover from them are reflected in the low resilience and coping mechanisms found throughout the region, with a significant reliance on rain-fed agriculture and increasing vulnerabilities to climate change and extreme weather shocks which disproportionately affect the region's poorest populations.

Sub-Saharan Africa is making progress in terms of economic growth, but climate change adaptation is difficult due to limited resources. In order to increase resistance to climate change and enhance coping strategies, economic growth must be advanced, as demonstrated by numerous research (IMF 2017; IMF 2019a; Hallegatte and others 2017). Policy suggestions range from creating safety nets and buffers like international reserves) to bolster the institutions and frameworks that support structural reform. Political ambiguity and security concerns may lead to new difficulties. This chapter covers policy and structural areas to help the region become more resilient to climate change and enhance coping strategies. Big data, econometric analysis, and event studies are used to present an overview of how climate change is affecting the region, with an emphasis on the effects of economic

[122] Y. Mohammed, M. Mustafa, N. Bashir, I. Ibrahem, Existing and recommended renewable and sustainable energy development in Nigeria based on autonomous energy and microgrid technologies, Renew. Sustain. Energy Rev. 75 (2017) 820–838.

growth and inequality. Econometric analysis of macro-level data, household surveys, and case studies are used to highlight the major policy areas that are most successful in fostering resilience and coping methods.

2.6.1 Adaptation Strategies

According to the October 2019 Fiscal Monitor, Chapter 1; IMF 2019b; Nyiwul 2019; Sub-Saharan Africa can increase mitigation and its contribution to a green economic recovery from the COVID-19 pandemic by enacting carbon taxes, eliminating energy subsidies, switching to green energy sources, reforestation that encourages carbon capture, and financial regulations that limit investment in polluting capital. However, the region has a larger need for adaptation techniques to increase employment and aid in the economy's ability to recover from the pandemic. In addition, climate-sensitive industries are especially important to the economies of Sub-Saharan Africa. Furthermore, compared to advanced and sizable emerging market economies that generate the most greenhouse emissions, the region has little impact on the climate. Growing policy discussions about adaptation are taking place throughout the area, as young people call for more urgent action from decision-makers.

Governments can create comprehensive adaptation policies by being aware of the beneficial interactions between adaptation, the macroeconomy, and development outcomes. Without climate change, enhanced seeds' capacity to lessen crops' sensitivity to the weather can increase agricultural productivity. This is also true for economic efficiency and governance, particularly implementing laws to promote laws aimed at promoting weather resilience. Access to financing, land reforms, and strong social protection is important for rural households to protect their assets from climate change (Kosec and Mo 2017). Limiting the effects of climate shocks and pursuing exchange rate flexibility are sound macroeconomic and structural policies that help the economy recover more quickly. Regional cooperation is essential for adaptation, as international borders are irrelevant to climate change. Consider the drying of Lake Chad and the Volta Basin, which endangers the hydroelectricity and food production of a few nations, including Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, and Togo (for the Volta Basin) and Cameroon, Chad, Niger, and Nigeria (for Lake Chad). Technology, expertise, and efficient institutional practices that are actively shared, particularly through regional initiatives, can significantly speed up adaptation (African Union 2014; EAC 2011; Lesolle 2012; Sembiring 2018). Creating local agricultural markets can bring down food costs and promote food security.

i) Preserving Food Safety

Crop damage brought on by the weather might leave hungry households. While food costs rise for other households due to shortages, subsistence farmers directly suffer. To meet this challenge, it is necessary to increase the productivity of agriculture, household resilience, and post-shock assistance.

Increasing coping mechanisms and household resilience can considerably lower the probability of food insecurity.

ii) Strategy for Coping and Resilience

These are essential for successful adaptation to climate change. Strong collaboration within the government (especially between the Ministries of Finance, Agriculture, Education, Environment, and Health, as well as those ministries and agencies responsible for certain forms of infrastructure), as well as with development partners, will be necessary to implement these policies. In order to implement the most effective combination of resilience-building projects, this process starts by developing adaptation strategies, evaluating whether governments' expenditure frameworks already account for key adaptation policies, and reviewing project selection and prioritization criteria. Informational asymmetries and financial constraints must also be addressed.

iii) Storms and Flooding

Given that major storms, such as tropical cyclones, also cause catastrophic flooding, policies for mitigating the effects of storms and floods sometimes overlap. By (i) lowering out-of-pocket medical costs, which protects household savings; (ii) facilitating a quicker return to work; and (iii) working with education to improve productivity, income potential, gender inequalities, and better-informed decision-making, health care plays a significant role in reducing the medium-term economic growth impact of floods and storms—which can also spread pandemics (Hallegatte, Rentschler, and Rozenberg 2019).

Access to finance supports the findings of the household survey study by assisting households and businesses in making investments in weather-resistant infrastructure and by acting as shock absorbers. In this regard, mechanical use can enhance agricultural production's resilience by enabling the construction of dikes, erosion control, and deeper seeding. Expanding mobile network coverage, especially in rural regions, promotes early warning system accessibility. Urban areas can be shielded from coastal erosion and flooding through weather-resistant infrastructure, such as large beaches and extensive drainage systems (Hinkel and others 2012). A major regional commercial and transportation hub in Mozambique, the Beira port, was able to resume operations three days after being affected by Hurricane Idai, and rail and road connections were operational within two weeks because of these efforts.

iv) Developing Broad-Based Adaptability

A combination of measures targeted at the different sorts of climate change issues a country faces will be necessary to increase resilience and strengthen coping mechanisms at the economy-wide level. Along with the above-mentioned methods, strong macroeconomic, institutional, and structural policies are required to achieve food security. Beyond that, there are crucial structural reform areas where improvement could result in significant benefits in limiting the impact of climate change on economic development and inequality. These areas are based on specific climate change issues. In the end, having excellent coping skills and resilience could completely prevent negative outcomes (Acevedo and Noah, forthcoming). (IMF 2015; October 2019 World Economic Outlook, Chapter 3).

v) Migration and Urbanization

The fast urbanization that results from rural inhabitants moving to cities in an effort to escape the effects of climate change, which most severely hit agricultural communities, calls for a multifaceted strategy. This movement of people and capital between geographical regions and industries of production will be made easier with the expansion of urban infrastructure (housing, drainage, sanitary facilities, and roads), health care, education, and targeted social assistance programs.

vi) Droughts

During extended dry seasons and water shortages, improved irrigation systems and greater access to financing, energy, and drinking water would encourage stronger economic growth and decrease of poverty. These elements complement one another: deep tube well pumps and irrigation systems are powered by electricity, and all three can be built and maintained easily thanks to financing availability ease thanks to availability to financing. The relative impact of these reform areas is a strong indicator of their relevance, even though the exact amount of this analysis should only be viewed as suggestive. The diversification of electricity sources toward renewable energy sources, such as geothermal, solar, and wind power, will play a significant role in expanding access to electricity. Droughts can affect hydropower, which produces one-fifth of the electricity in sub-Saharan Africa (Castellano and colleagues 2015). A quick fix is to increase the number of power plants, reservoirs, and dams. Reduced reliance on hydropower also makes it easier to manage water resources; in Ghana, this will require building and maintaining tiny dams and boreholes as well as implementing solar irrigation systems.

2.6.2 Financial Assistance

For Sub-Saharan Africa, addressing climate change through funding adaption measures will be expensive—estimated at US$30–50 billion (2–3 percent of regional GDP) per year over the next decade —but significantly less expensive than often providing disaster assistance.

Given its advantages, Sub-Saharan African nations with constricted budgetary space find it difficult to finance adaptation. The moderate to high debt vulnerabilities that most of these nations already experience have been made worse by the high expenditures of combating and controlling the COVID-19 outbreak. As a result, despite considerable policy overlap, nations must weigh conflicting development demands before taking on extra debt obligations. Although their breadth is constrained and their development is gradual, countries are actively exploring changes to increase income generation (particularly through environmental levies) and increase spending efficiency. If global mitigation efforts proceed, oil and coal exporters will also face the challenge of declining earnings, underscoring how important it is for these nations to accelerate economic diversification. Following this regard, a few nations have established disaster funds, such as Mozambique, where a portion of the funding comes from yearly budget allotments. The nations of Sub-Saharan Africa are also figuring out methods to help one another. For instance, the African Risk Capacity is a regional macroeconomic insurance scheme that, as of March 2020, had 34 member nations. Given the high-risk premiums, which partly reflect governance concerns in many Sub-Saharan African nations and increase the risk aversion of investors and development partners, using macroeconomic insurance instruments, such as climate funds and issuing state-contingent bonds, has so far proved challenging.

The world community has the power to significantly alter events. Development partners should promote resilience building and strengthen coping strategies in addition to disaster relief (especially by offering global insurance products). Not only is it a moral duty, but it will also help compensate for the fact that those who are most responsible for climate change have not fully internalized the costs of greenhouse gas emissions (World Economic Outlook, October 2017; IMF 2019a). According to estimates, developing nation’s estimated financial needs are substantially beyond the US$25 billion in worldwide public support for adaptation (Puig and others 2016). Additionally, resilient infrastructure sponsored by development partners provides the same level of welfare as regular disaster aid at a cost savings of at least 30% (Cantelmo, Melina, and Papageorgiou 2019).

Institutions of international finance may also actively participate (IMF 2019a). Through a variety of tools (including loans and guarantees) and by lowering investment risk, they can open financial pools for adaptation. By offering financial support, policy guidance, and capacity building, the IMF has been more involved in the region's efforts to strengthen resilience and ex-post-implement recovery plans. For instance, the IMF helped Comoros and Mozambique recover from storms Idai and Kenneth by providing US$130 million under the Rapid Credit Facility, and US$40 million to Malawi by expanding the already-existing Extended Credit Facility. The combined work of the IMF and the World Bank on Seychelles' Climate Change Policy Assessment is one example of efforts to strengthen policies and capability in response to climate change challenges (IMF 2017).

2.7 Main National Actors in the Management of Cameroon's Energy Sector. Table 6

According to the institutional framework outlined in Situation Energétique du Cameroun (2015), the Ministry of Water and Energy (MINEE) oversees the designing, developing, implementing, and overseeing government policy in the energy sector since it has technical oversight over the industry. In Cameroon's electricity sector, however, several actors—public, semi-public, and private businesses, as well as some associative financial institutions—each have distinct responsibilities:

Entity	Description
The Ministry of Energy and Energy Resources (MINEE)	MINEE oversees the design and implementation of the national energy policy
The Ministry of Economy, Planning, and Regional Development (MINEPAT)	MINEPAT works with MINEE to promote investments in the electricity sector
The Ministry of Finance (MINFI)	MINFI provides financial support and different incentives such as Value Added Tax (VAT) exemptions to boost the RE sector
The Ministry of Scientific Research and Innovation (MINRESI)	MINRESI is responsible for conducting research in the energy and hydrological fields and, in conjunction with MINEE, is responsible for promoting new energy
The Ministry of Environment, Protection of Nature, and Sustainable Development (MINEPDED)	MINEPDED is responsible for the promotion of sustainable development in the renewable energy sector
The Rural Electrification Agency (AER)	AER is a legal public entity with financial autonomy responsible for promoting and implementing rural electrification programs in Cameroon. It also manages the Rural Energy Fund (FER)
ARSEL – Agence de Régulation du Secteur de l'Électricité (The Electricity Sector Regulatory Agency)	ARSEL ensures the regulation, control, and monitoring of the activities of operators in the electricity sector, within the framework of policies defined by the government of Cameroon. ARSEL also ensures the setting of electricity rates and determining electrical standards
The Electricity Development Corporation (EDC)	EDC oversees the construction and development of all hydroelectric projects in Cameroon. It also plays a strategic role in the development of the electricity sector while ensuring conservation of the public heritage in the sector
ENEO Cameroon	ENEO is the main power generator in Cameroon. It is responsible for power generation, transmission, and distribution in the country
SONATREL – Société Nationale de Transport de l'Électricité (The National Society of Transport Electricity)	SONATREL is responsible for the operation, maintenance, and development of public electricity transmission networks throughout Cameroon, as well as the management of energy flows that pass through it

The Independent Power Producers (IPP)	These are private distribution companies

The figure below shows the Sectoral Institutional Setup of the Main National Actors

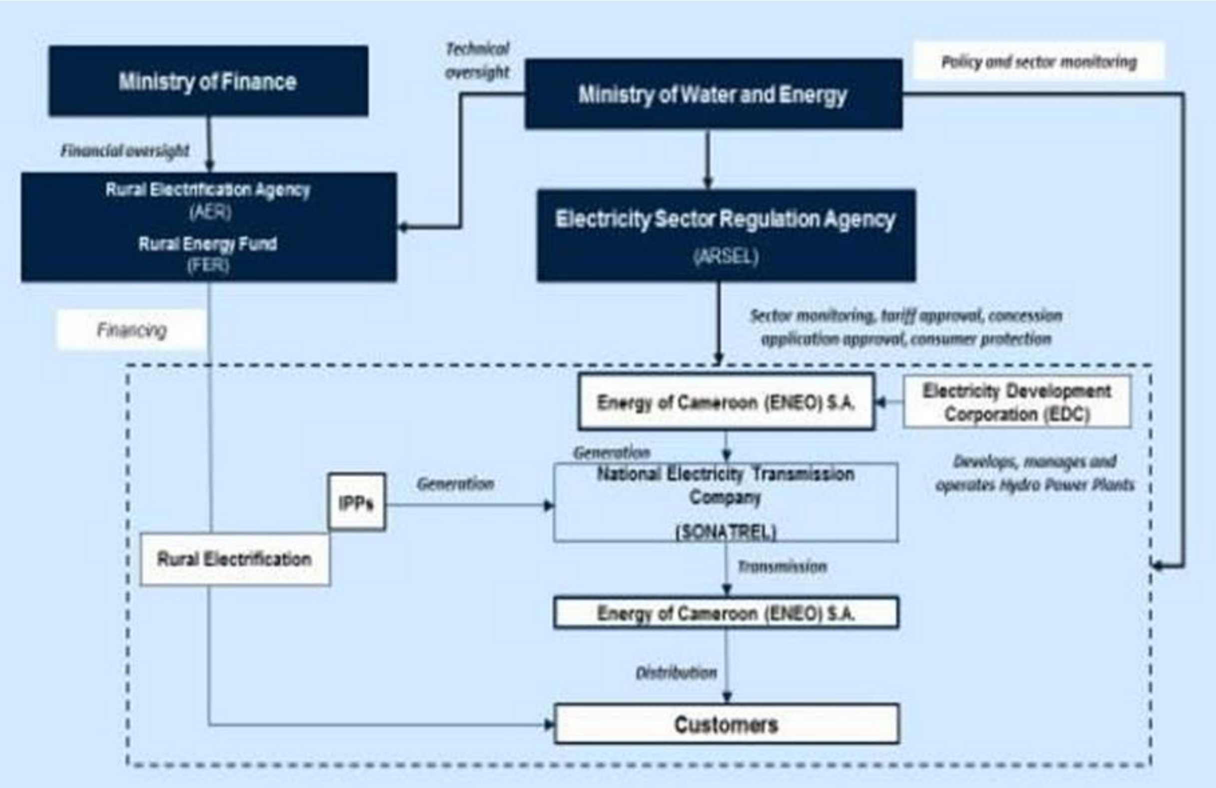

Figure 6: Sectoral Institutional Setup of the Main National Actors in the Management of Cameroon's Energy Sector[123]

It is important to keep in mind that a few laws, most notably Law N°2011/022 of December 14, 2011, which replaced Law N°98/022 of December 24, 1998, govern the electricity industry in Cameroon. This law includes the rules governing the production, distribution, sale, and transportation of electricity, whether it comes from main or secondary sources. In more detail, it addresses (i) regulation of water storage and hydroelectricity, (ii) regulation of competition in the electricity sector, (iii) regulation of non-competitive activities, (iv) regulation of environmental protection in the electricity sector, (v) regulation of consumer protection, (vi) regulation of internal electrical installations and electrical equipment, (vii) establishment of a Transmission System Operator (TSO) for electrical energy, and (viii) establishment of a TSO for natural (viii) electrical energy control and renewable energy.

[123] Source: World Bank, December 2018

2.7.1 Country Priority Plan: Government Strategies and Targets

The National Development Strategy 2020–2030, which was authorized in 2020, is the overarching national strategy for structural transformation and inclusive development adopted by the Government of Cameroon (GoC). The following initiatives have presently been adopted by GoC at the energy sector level:

- Update of the Electricity Sector Development Plan (2014)
- Policy, Strategy & Action Plan for Energy Efficacy in the Electricity Sector (2014)
- Rural Electrification Development Plan (2016), and
- Electricity Sector Development Fund (2020)

The following graph summarizes the primary policy goals and their present state as of today:

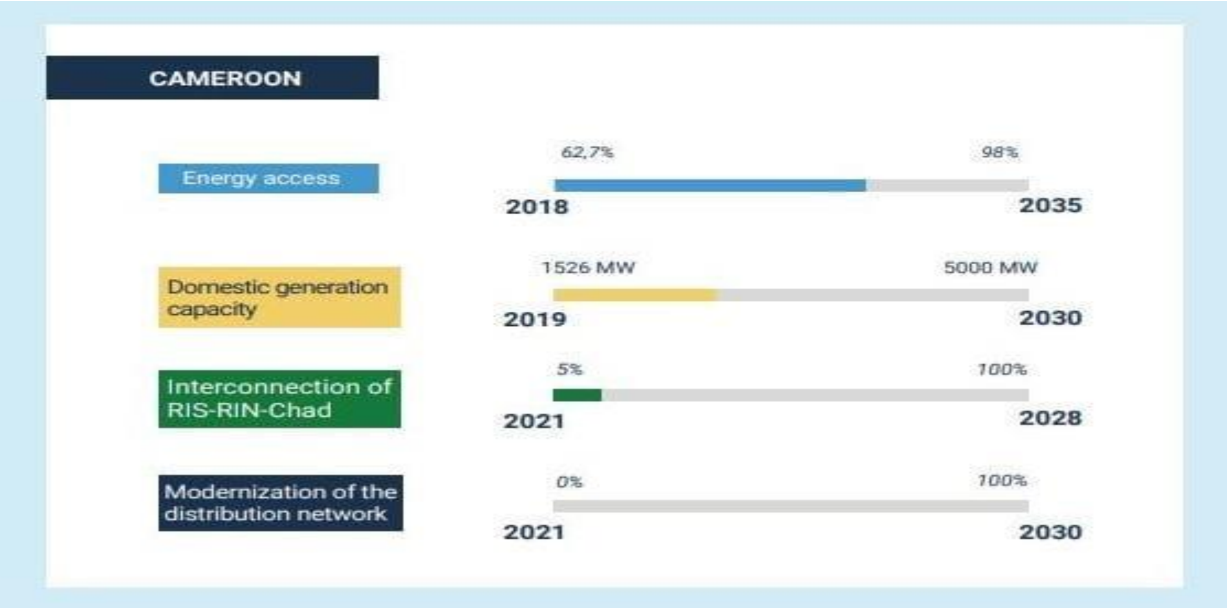

Figure 7: Cameroon Policy Targets. Source: Tony Blair Institute for Global Change (TBI)

The policy objectives in greater detail:

a) Energy Access: The GoC hopes to achieve universal access (100%) by 2035 using both grid-connected systems and off-grid solutions, with a current entry rate of about 63%. The following intermediate goals are unique to this mandate:

i. Establish 250,000 new on-grid connections every five years (so 500,000 by 2030).

ii. By 2030, connect 20,000 people using off-grid technologies.

Develop the nation's hydro potential at Bini à Warak (75 MW), Natchigal (420 MW), Ngoila (84 MW), Song Ndong (280 MW), Grand Eweng (1800 MW), Chollet (600 MW), Kikot (720 MW), Makay (350 MW), Moila Mongue (420 MW), and Njock to increase generation capacity by 3,500 MW (to reach a target of 5000 MW) by 2030. (200 MW).

b) **Reinforcement of the transmission network:** The interconnection project and the South-North backbone will be supplemented by the construction of a contemporary dispatch centre and the strengthening of several substations to make room for the additional transmission lines.

c) **Modernize the distribution network:** Renovate existing distribution lines in significant urban areas, install smart equipment to enhance network management (including remote operations), and roll out smart meters to lower business losses and boost collection rates.

2.7.2 Summary of Sector Outlook: Generation Outlook

In the next ten years,[124] the GoC projects that the country's consumption will increase at a 6.7% annual rate. However, several of the master plan's predicted mining ventures have yet to materialize, so this growth needs to be confirmed by an update to the Master Plan. The GoC has also started a drive to encourage local industries to use electricity. Hydropower is the most practical solution to meet the demand for energy, according to Cameroon's 2014 Least Cost Power Sector Expansion Development Plan (Plan de Développement du Secteur de l'Electricité, PDSE). The Sanaga River Basin provides the best chances among all locations to scale up generation capacity well beyond national requirements. The Lom Pangar Hydropower Plant Project, which will increase the guaranteed, all-season hydropower capacity on the Sanaga River by about 40%, was anticipated to be fully operational by the end of 2021 (the dam is already operational, and it is regulating the water flow, already increasing the water availability for other existing plants). The Sanaga River could contribute 6,000 MW of capacity overall through both sizable and small hydropower facilities. Four priority interventions have been selected by the masterplan within this framework:

1. The Natchigal hydropower plant is an important investment that will boost the grid's generation capability by nearly 30% with its 420 MW. This project is still being built even though it was meant to be finished in 2019. The construction of the dams was scheduled for this year 2023.
2. The 84 MW Menchum hydropower plant facility scheduled to open in December 2017, has been affected by the crisis in the North West and South West regions. There are currently no project developers, and it is unclear if and when the plant will be supplied.
3. A fresh, forward-looking hydro initiative with 2,136 MW of installed power, including Kpep (556 MW), Kikot (600 MW), Grand Eweng (700 MW), and Song Ndong (270 MW).
4. Due to a shortage of gas supply, the extension of the Kribi gas power plant (114 MW), which was originally scheduled for 2016, has been postponed.

Given the political and fiscal crisis the country is currently experiencing, it is significant to note that a few projects are not progressing as quickly as they were intended to in the 2014 update of

[124] IEA Enerdata.

the Master Plan. More precise commissioning dates and prioritization will be provided by the suggested update to the Master Plan.

2.7.3 Transmission Outlook

Given its hydroelectric energy potential and its location within the region, Cameroon can serve as both a source of electrical energy for its neighbours and a pathway for energy to be transported to countries in the north and west, the Republic of the Congo, and the south (Chad and Nigeria). In this situation, Cameroon can implement the 400 kV level to acquire large amounts of electric power from the Republic of the Congo, transmit them through the Southern Interconnected Network, and then deliver them to Nigeria and Chad.

Two initiatives are currently being developed and are being funded by the World Bank and the African Development Bank (AfDB). The first is the connection with Chad, and the second, funded by the World Bank, complete the AfDB-financed interconnector that was authorized in December 2017. A 2x225kV (HV) main transmission line measuring 566 km between Ngaoundéré and Maroua (Cameroon) and N'Djamena (Chad) will be financed by the AfDB initiative. The project is moving forward after the completion of the feasibility studies, preliminary and detailed designs, bid packages, environmental and social effect assessments, and resettlement action plans in May 2017. The chance to enable power exports from southern Cameroon to Chad in the medium term underpins the AfDB project's justification.

In contrast, the World Bank project will build a 514 km high voltage transmission line to join the Natchigal substation of the Southern Interconnected Network and the Hourou Oussoua substation of the Northern Interconnected Network. As a result, the national power system will be more resilient as the Northern and Southern systems can now link.

Figure 8: Donors' Programs to Increase Energy Access in Mozambique from RESs both On-Grid and Off-Grid Solutions.[125]

[125] Source: World Bank: Cameroon and Chad Interconnection Project.

Additionally, the proposed Project would start the foundational infrastructure needed to build the Country Priority Plan (CPP) over time in tandem with the AfDB project. The procurement process for both projects is continuing, and their combined estimated cost is close to USD 700 million. The building is anticipated to be completed in 2028.

The national transmission network will become more complicated because of the execution of this project. As a result, SONATREL needs to make several investments to be able to operate the system effectively, but they presently have no financial support. Quantification is not feasible because no feasibility studies have been conducted yet.

The following are mentioned after the crucial ones:

- Development of a cutting-edge dispatch facility
- Digitalization of the communication network
- Reinforcement of substations in Yaoundé
- Elaboration and implementation of a grid code and an operational manual

By 2025, ENEO intends to update the delivery networks in Yaoundé and Douala. The project teams mobilized in the first quarter of 2021 after the feasibility studies were finished, and the initial equipment purchases were made. This project aims to upgrade the networks (more energy transit capacity, more backup lines to reduce incident frequency and duration), build new underground and overhead lines, and implement a smart system (SCADA) to improve distribution network monitoring and intervention times, among other things.

2.7.4 Summary of the Main Challenges to Address

There are several difficulties facing the electricity industry in Cameroon. The primary problem at the institutional level is the lack of high-level, coherent strategic goals that examine how various natural resources will impact the power sector. The new Integrated Masterplan 2022–2035 should then be created using this approach. The full operationalization of the transmission company SONATREL is another high concern. It is crucial to help ENEO reduce the high level of distribution losses, implement tariff adjustments in accordance with ARSEL's suggestions, and mobilize funding for investments by public companies in the sector if the sector is to improve its financial stability.

In terms of producing electricity, the structure and development of the generation capacity are the primary areas of uncertainty. A new plan is required to harmonize and direct future investment because investments have diverged from the present Master Plan. Prioritizing the updated combined master plan will be necessary, along with considering a deeper gas introduction. In addition, structures and systems must be put in place through "programmification" and Public-Private Partnerships (PPPs) to connect the Master Plan to phased project execution and advance the priority investments outlined in the updated plan in a structured, open, and competitive way.

Recent drought-related events have made it clear that hydroelectric projects need to be better planned and managed because climate change will likely affect the Region more severely. The water shortage in the Benoué region at the end of 2020 is a striking illustration of what is likely to occur more frequently in the future. The incident has had a significant effect on production from the Lagdo dam, which was said would not be fully pumped for the entirety of 2021. Despite the plant's high availability rate of its machines (nearly 90%), this suggests low generation from the plant for at least the entirety of the first semester of 2021. As a result, an emergency plan to deliver electricity to the North has led to the installation of nearly 30 MW of gensets, significantly raising the cost of electricity and CO_2 emissions.

Even at the network level, ENEO's technical and commercial losses are still very large (around 30%), and they must be reduced if the industry is to attract more capital. This will require considerable work to restore the current grid and investment in new machinery, as well as improve network stability throughout all its license areas, not just in the two main cities. Making SONATREL fully operational to manage the Transmission System Operator's (TSO) role presents additional challenges, as does a network that is still fragile, divided into Southern, Eastern, and Northern zones, and still disconnected from the regional power pools. Other challenges include the following: i) The GoC mobilizing the counterpart money, ii) speeding up the compensation orders and funding mobilization processes; iii) transferring project payments into foreign accounts when necessary.

To reduce the cost of provision, access policies in the off-grid segment must concentrate on rehabilitating and expanding distribution networks as efficiently as possible. Access in rural or low-income regions is financially unprofitable, just like in every other SSA nation. Because of this, ENEO will need to implement electrification programs that either involve large subsidies (given that the nation has hit its debt and fiscal deficit limits) or high tariffs that run the risk of not being able to meet demand). Given that ENEO will not be able to fund or raise financing for unprofitable access programs, access investments will be pushed into safer and comparatively higher-income areas in an effort to reduce negative financial effects and the risk of a lack of (timely) subsidies. To ensure ENEO's financial viability, in addition to reducing technological and commercial losses, it is urgently necessary to resolve the company's liquidity issues by restructuring its debt and assisting it in carrying out its ten-year investment plan.

The GoC and state-owned businesses have significant debts and arrears (at the end of 2019, the total amount of these debts and arrears was XAF 65 billion, while the total amount of ENEO's credits was XAF 180 billion), which places pressure on ENEO's finances. To relieve the company's liquidity concerns in 2020, GoC issued specific treasury bonds to settle XAF 45 billion of its overall arrears. This scenario suggests that ENEO owes suppliers and IPPs a sizeable sum of money—roughly XAF 155 billion. In terms of the ten-year investment strategy, as of 2021, ENEO had only been successful in raising XOF 100 billion out of the required 521 billion. Support must be provided to the business to hasten plan implementation so that distribution systems in other cities can be improved and expanded.

2.8 Relationship between Research, the Literature, and Some Identified Gaps

Cameroon, like the majority of SSA nations, has a wealth of RESs and the potential to build energy communities, but it has difficulties successfully and efficiently utilizing them. In order to lessen the adverse effects of climate change, researchers emphasize the need for hydropower-dependent nations like Cameroon to diversify and incorporate other green energy sources into their energy mix. According to Egute, T., Albrecht, & Ateghang (2017), a strong energy strategy is essential for ensuring Cameroon's energy security in the future. However, a thorough study of the gaps in the literature on energy communities and renewable energy in Cameroon is limited. A few examples include the limited research on the social and economic impacts of energy communities on local communities, the absence of research on the technical and financial viability of RE projects, the difficulties of implementing energy communities in rural areas, the role of RE and energy communities in promoting sustainable development, and the impact on RE of energy communities. In his article, C. Iaione emphasized that Tech Justice is an empirical dimension that can guide the growth of smart city initiatives and sharing city policies toward a more just and democratic city. This was his primary point.[126] The analysis of the gaps in the literature is limited and lacks specificity. To encourage the development and adoption of energy communities and RE technologies in Cameroon, a more thorough analysis of the gaps in the literature may be able to pinpoint specific research issues and areas that need to be further investigated.

Much of the literature on the subject is put forward by economists, energy, and environmentalists with little legal input. There is a significant gap in the body of literature, as there is a scarce legal analysis that fully critiques the domestic climate regime's institutional characteristics, rules, and processes. Furthermore, climate change regulation is evolving, and most of the published literature depicts an inaccurate assessment of some present international and domestic legal frameworks. Averchenkova A. et al (2019) have argued for a comprehensive, published, evaluation of national and international legal frameworks needed to monitor greenhouse gas emissions and address the implications of climate change effectively.

[126] C. Iaione, Legal Infrastructure and Urban Networks for Just and Democratic Smart Cities, Italian Journal of Public Law, Vol. 11, Issue 2/2019

CHAPTER 3

METHODOLOGY

3.1 Cameroon's Renewable Energy Laws and Policies

In the past, the nation has depended on changes to the electricity industry, with hydroelectricity leading the way because it is more developed than other RE sources like wind, solar, and biomass. The growth of hydroelectricity was the sole focus of Law N°98/022 of the Electricity Sector, which is general legislation governing the electricity sector, at first. Following that, the Electricity Law 2011/022, which was enacted on December 14, 2011, and governs the electricity sector, explicitly defined RE sources.[127] The State's role in:

- Promoting and developing RE,
- Creating the opportunity for the transmission system operator or any local distributor to purchase the excess electricity produced by RE sources,
- Establishing tax benefits for goods and services intended for RE exploitation were some of the significant changes made by this new legislation, and
- Establishing a company in charge of RE research and promotion.

Through the establishment of the Department of Renewable Energy within the Ministry of Energy and Water Resources, this legislation exactly shapes the legal and institutional supervision for RE promotion.

A few government plans and programs for energy development have been announced in response to the rising demand for electricity, and results are greatly anticipated. The Cameroon Master Plan for the Development of RE has not yet been made public. The master plan for rural electricity, which also emphasizes RE like solar energy in the northern regions and hydro energy in the southern regions, is about to be made public. The ESDP up to 2035 is the most recent government plan intended to assist in defining, for various scenarios of demand forecasting, optimal sequences of facilities that are the least expensive solutions to cope with the demand, or to increase the reliability of the electrical system, using the significant identified hydroelectric sites of the nation. The demand forecast for the ESDP 2035 considers national requirements as well as electricity exportation to Nigeria's neighbours, the Central African Republic (CAR), and Chad. Short-, medium-, and long-term scenarios are also studied and examined. The nation has established challenging RE goals, such as installing more than

[127] National Assembly, Law governing the electricity sector in Cameroon, Yaoundé, 2011 [Google Scholar]

5500 MW of hydropower by 2035,[128] in an optimistic long-term situation. The optimistic long-term scenario predicts a desire for an interconnection with Nigeria estimated at 500 MW from 2031 to 2035 and with Chad estimated at 150 MW in 2035 in terms of exportations.

It is important to keep in mind that a few laws, most notably Law N°2011/022 of December 14, 2011, which replaced Law N°98/022 of December 24, 1998, govern the electricity industry in Cameroon. This law includes the rules governing the production, distribution, sale, and transportation of electricity, whether it comes from main or secondary sources. In more detail, it addresses (i) regulation of water storage and hydroelectricity, (ii) regulation of competition in the electricity sector, (iii) regulation of non-competitive activities, (iv) regulation of environmental protection in the electricity sector, (v) regulation of consumer protection, (vi) regulation of internal electrical installations and electrical equipment, (vii) establishment of a Transmission System Operator (TSO) for electrical energy, and (viii) establishment of a TSO for natural (viii) electrical energy control and renewable energy.

3.2 Government Policies

Cameroon has a wide range of energy development strategies. Energy for development was a major focus of Cameroon's Growth and Employment Strategy Paper (GESP), which covers the ten-year period from 2010 to 2020. A goal of 3000 MW of extra installed hydropower capacity was set for 2020. This entailed the construction of new power-generating facilities (primarily hydro), the modernization of the infrastructures that make up the national electricity network, and the marketing of cutting-edge, environmentally friendly energy services, particularly for rural areas. Additionally, a 2030 Energy Sector Development Plan was created with the objective of achieving a 75% overall increase in energy access and a 20% rate of rural electrification. Another plan, the Rural Electrification Master Plan (REMP), has as its objective the electrification of 660 communities using mini-hydro and grid extensions within a context of diversification (Muh et al., 2018).

The National Energy Action Plan for Poverty Reduction (NEAPRP), whose primary objective was to improve access to contemporary energy services for social infrastructure such as educational and medical facilities, acknowledged the connection between energy and poverty in 2007. The strategy emphasizes energy poverty as a hindrance to Cameroonian human development. The significance of electricity for lighting, communications, and technical services, as well as the promotion of safer and more effective cooking methods like "les foyers améliorés"[129] (improved ovens), were emphasized

[128] Power Africa Off-grid Project (USAID), Off-Grid Solar Market Assessment Cameroon, 2019. https://www.usaid.gov/sites/default/files/documents/1860/PAOP-Cameroon-MarketAssessment-Final-Digital_508.pdf [accessed 02.04.23] [Google Scholar]

[129] Improved cookstoves are devices have a more efficient heat transfer, emit less emissions, and are safer than traditional open pit stoves.

throughout the report. The document specifically used the Millennium Growth Goals (MDGs) framework to emphasize the beneficial connections between increased access to energy services and human growth. The Document de stratègie de reduction de la pauvretè (DSRP), Cameroon's national poverty reduction plan, was created in response to the MDGs. However, the strategic plan failed to recognize and utilize energy as a significant factor in reducing poverty and enhancing human welfare. According to NEAPRP, switching from conventional to contemporary energy for cooking serves to improve public health, safety, and gender equality (ESMAP, 2007, 35).

3.3 Energy Gap

Since Cameroon has a wealth of energy resources, the gap between energy production and demand cannot be attributed to the country's limited energy resource potential. Numerous experts agree that the primary issue at hand is the Cameroon government's poor management, regulation, and promotion of the energy sector (Mas'ud et al., 2015; Adom, 2016; Tamba, 2017; Wirba et al., 2015). Hydropower provides most of the energy needed in Cameroon. Because of this dependence on a single energy source, Cameroon experiences frequent power outages, especially in rural and semi-urban areas. growth of sustainable renewable energy sources may play a significant role in propelling growth in Cameroon. The lack of modern energy access, however, continues to have an impact on economic and socioeconomic progress in Cameroon. The transition to a low-carbon energy infrastructure and expanding energy access levels present two competing obstacles. Unfortunately, Cameroon's lack of effective governance coordination and action prevents the growth of sustainable renewable energy sources. Off-grid options to boost accessibility and resilience as well as government regulation to encourage RE development might satisfy the population's energy needs in Cameroon.

3.4 Climate Governance in the Northern City - Garoua, Cameroon

The City of Garoua in Cameroon is committed to taking climate action, with support from the Covenant of Mayors in Sub-Saharan Africa (CoM SSA). To achieve this, the city is working to complete its Sustainable Energy Access and Climate Action Plan (SEACAP) and has completed its baseline reports. These reports include the Baseline Emissions Inventory (BEI), Risk and Vulnerability Assessment (RVA) and Access to Energy Assessment (energy Profile). These reports are essential for providing data to inform the development of actions to reduce greenhouse gas emissions and improve access to secure, sustainable, affordable, and reliable energy. Climate change and energy planning are important topics discussed at a workshop in Garoua, Cameroon.

Participants discussed the need for priority sectors, targets, and actions to increase the city's resilience to climate change by 2035. The workshop focused on setting up a climate-resilient target for the Environment, Biodiversity and Forests sector to rehabilitate the Bénoué riverbanks, increasing biodiversity and water infiltration, preventing riverbank erosion, and preventing climate hazards. The city's SEACAP is also being developed to target the Water and Health sector, increasing access to clean water to help reduce the spread of waterborne diseases. CoM SSA is enabling cities to take climate leadership, starting with the first step of assessing and planning for climate change.

3.5 Population Dynamics in Garoua

Garoua was established by the Fulani emir Modibbo Adama in the first half of the 19th century. It became a major river port when steamships were in use. In 1967, the city's population was 30,000.[130] The Benue River runs through Garoua, which is in northern Cameroon. It acts as the entry point to Benoué National Park.[131] There are several areas nearby the Garoua International Airport,[132] including Commercial Centre, Lopere, Quartier de Marouare, Poumpoumre, Roumde Adjia, and Yelwa in the northwestern suburbs.

Garoua has a tropical savanna climate, with a wet season and a dry season and the temperature being hot year-round. The coldest months, December and January have an average temperature of 26.0 °C (78.8 °F), while the hottest month, April, has an average temperature of 33.0 °C (91.4 °F). Just before the onset of the wet season, in March and April, is when it gets the hottest. The average high for March is 39.8 °C (103.6 °F), and the average low for April is 26.4 °C (79.5 °F). The lowest average high is 30.7 °C (87.3 °F) in August, and the lowest average low is 17.3 °C (63.1 °F) in December.

Figure 9: City of Garoua location map[133]

[130] Mark Dike DeLancey, Rebecca Neh Mbuh, Mark W. Delancey, Historical Dictionary of the Republic of Cameroon, Scarecrow Press, USA, 2010, p. 189
[131] Ham, Anthony (2009). West Africa. Lonely Planet. p. 207. ISBN 978-1-74104-821-6.
[132] Google Maps. Google. Retrieved 16 April 2023.
[133] https://en.wikipedia.org/wiki/File:Cameroon_-_North.svg &https://www.google.com/maps/place/Garoua,+Cameroon/

Garoua experiences a distinct wet and dry season, like most tropical savanna climates, and gets 997.4 millimetres (39.27 in) of rain over 88 days of precipitation. The months of December, January, and February are completely dry. The usual rainfall in August, the wettest month, is 247.9 millimetres (9.76 in). The month of September has the most precipitation days, with 24. Average yearly sunshine hours in Garoua are 2927.1, with sunshine hours evenly spread throughout the year, though they are lower in the wet season. Fig…illustrates the climate data for Garoua.

Climate data for Garoua [hide]													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	34.4 (93.9)	37.3 (99.1)	39.8 (103.6)	39.5 (103.1)	36.5 (97.7)	33.2 (91.8)	31.1 (88.0)	30.7 (87.3)	31.5 (88.7)	34.2 (93.6)	36.0 (96.8)	34.8 (94.6)	34.9 (94.8)
Daily mean °C (°F)	26.0 (78.8)	28.9 (84.0)	32.2 (90.0)	33.0 (91.4)	30.7 (87.3)	28.2 (82.8)	26.6 (79.9)	26.4 (79.5)	26.7 (80.1)	28.1 (82.6)	27.3 (81.1)	26.0 (78.8)	28.3 (82.9)
Average low °C (°F)	17.5 (63.5)	20.5 (68.9)	24.7 (76.5)	26.4 (79.5)	24.9 (76.8)	23.2 (73.8)	22.2 (72.0)	22.0 (71.6)	21.9 (71.4)	22.2 (72.0)	19.2 (66.6)	17.3 (63.1)	21.8 (71.2)
Average rainfall mm (inches)	0.0 (0.0)	0.0 (0.0)	2.0 (0.08)	44.1 (1.74)	108.4 (4.27)	134.8 (5.31)	205.3 (8.08)	247.9 (9.76)	190.0 (7.48)	63.3 (2.49)	1.6 (0.06)	0.0 (0.0)	997.4 (39.27)
Average rainy days (≥ 1.0 mm)	0	0	1	5	9	11	14	17	24	6	1	0	88
Mean monthly sunshine hours	275.0	252.6	260.1	245.4	256.7	224.4	194.0	187.2	204.5	261.5	279.2	286.5	2,927.1

Figure 10: Climate Data for Garoua, Source: NOAA[134]

3.6 The Energy Sector in Garoua, Cameroon[135]

Among the objectives of the climate plan, the city of Garoua intends to strengthen its resilience to climate change in the most affected sectors such as agriculture, reduce its overall projected emissions by 25%, and extend household access to electricity to 90% by significantly increasing the production of renewable energy.

On 12 April 2022, the City of Garoua and its three subdivisional councils (Garoua I, II and III) launched their **Sustainable Energy Access and Climate Action Plan** (SEACAP)[136], a vast climate action programme for the 2030 horizon. This document outlines key goals, actions, and outcomes for the city to adapt to the impact of climate change and improve access to clean, sustainable, and affordable energy.

[134] "Garoua Climate Normals 1961–1990". National Oceanic and Atmospheric Administration. Accessed 14 April 2023.
[135] Covenant of Mayors in Sub-Saharan Africa; Garoua launches Cameroon's first intercommunal climate action plan. Published: 3 May 2022.
[136] The SEACAP is the result of workshops in collaboration with the city mayor's office, the 3 subdivisional councils, civil society and delegates from several ministerial departments, particularly those in charge of the environment, nature conservation and development; water and energy; and agriculture and rural development.

3.7 Renewable Energy Deployment Support Policies in Cameroon

Many measures that favour renewable energy could increase the use of renewable energy in Cameroon. These could include tax incentives, subsidies and loans, and feed-in tariffs. The feed-in-tariff (FiT) is the option that is best for Cameroon. The FiT must be implemented in Cameroon in order to guarantee the private sector's enthusiastic participation. By making up for the price discrepancies between the cost of producing renewable energy and conventional energy, the FiT system strives to support the commercial viability of the renewable energy industry. It makes up the price gap by levying fees or taxes on energy consumers or providing subsidies from the government or government-owned businesses.[137] Energy users or the public are ultimately responsible for the financial burden placed on the government as a result of making up the price gap. Despite the costs to the government and consumers, replacing traditional energy sources with renewable ones could increase social welfare by enhancing health, life expectancy, and quality of life while lowering environmental risks including pollution, deforestation, drought, and mass extinction of species. FiT's funding sources include the government budget and revenue from electricity fees. A more moderate approach ought to be used in order to lessen the burden of the FiT policy (Carsten Herbes et al., 2017).

The first stage is the Global Energy Transfer Feed-in Tariff (GET-FiT), a policy mechanism by which industrialized countries encourage the deployment of renewable energy in less developed countries by providing cash for the adoption and operation of FiT. The Cameroonian government may apply for the implementation of this program to the appropriate foreign financial institutions and ask developed nations whose energy corporations have active operations in Cameroon for funding for the initiative. Examples of donor nations include South Korea, China, Germany, France, and Belgium.[138] In this scenario, Cameroon might get a FiT premium from overseas sponsors, which the government would then match, bearing some of the cost. Independent Power Producers (IPP) of renewable energy sell electricity at a price agreed upon in advance with a transmission and distribution firm. With premiums paid by the government and international sponsors, the consumer of electricity produced using renewable energy is made up for the price difference between the wholesale and contract prices (Ana Cravinho et al., 2011).

To stop renewable energy power producers from making excessive profits, the Pre-FiT (PPA) program is introduced in the second stage and can be implemented regardless of whether the GET-FiT Program is implemented. Through a Power Purchase Agreement (PPA) between the renewable power producer and operators, it alludes to ensuring the financial success of renewable power producers. For

[137] F. Enow-Arrey, (2020), Renewable energy deployment policy-instruments for Cameroon: Implications on energy security, climate change mitigation and sustainable development. Bulletin of the Korea Photovoltaic Society Vol. 6 No. 1.
[138] *Ibid.*

Pre-FiT, a renewable energy IPP is chosen through a bid in a reverse tender, in which a reference price established by the government taking expenses into account serves as a price ceiling, whereas a PPA contract is made with a power distributor. Decisions about PPA application and contract procedures, businesses, and managing foreign investors must be made independently.

A FiT based on a Tender could be used in the third stage. This is an extension of the PPA, which is based on extensive national development initiatives. It should be implemented in earnest after sufficiently safeguarding track records through a Pre-FiT system sufficiently safeguarding track records through a Pre-FiT system, it should be implemented in earnest. Due to its strength in assuring constant revenue for renewable power providers while avoiding their excessive profits, the system needs to be based on the newly implemented tender-based FiT in several nations.

To safeguard domestic power producers, the FiT method should be used for small renewable energy projects without a competitive bidding process. FiT should therefore be implemented in stages, depending on the level of development of the renewable energy market and the ability of the government. The GET-FiT program's initial phases provide the groundwork for FiT, which will eventually transition to an auction-based system in the medium to long term. So, to maintain pricing in the renewable energy industry, a national renewable energy fund is required. Both Deutsche Bank and the KfW have extensive experience managing FiT in developing nations.[139]

3.8 Analysis of Local Level Readiness Assessment in the Energy Sector

S. Foster and C. Iaione argued that a link can be made between the normative claim to the city, its resources, and how both are managed through the framework of the commons. In their article, they ask *"What are the chances of introducing more collaborative governance tools to decisions on how city space and common assets are used, who has access to them, and how they are shared among a varied urban population?"* The authors acknowledge that the city is home to a variety of tangible and intangible resources, each of which is subject to the claims and interests of numerous users and other actors.[140] This section focuses on the local level of Garoua's readiness for the shift to a clean energy society, emphasizing positive trends and areas for development, considering the following law and policy tools.

- Local Policy Development
- Institutional Framework
- Stakeholders Engagement

[139] *Ibid.*
[140] S. Foster & C. Iaione, The city as a commons, 34 Yale L. & Pol'y Rev 281 (2016).

- Climate Change Litigation
- Energy Transition Projects

This evaluation is primarily based on the analysis of secondary data, such as legal and policy documents, current reports, and findings from city departments in Cameroon, interactions with city governance structures, technical research, the Garoua's SEACAP, case law, presentations, and in-depth examination of the city's energy sector.

Tool #1: Local Policy Development

Over two years, the city of Garoua developed the SEACAP which contains the results of 9 technical reports using literature reviews, surveys on 1,120 households, interactive workshops, and participatory mapping exercises. According to the survey report, most emissions come from four sectors: **transport** (first with 43% of emissions), **waste** (24%), **agriculture and livestock** (23%) and finally **stationary energy** (10%). If no climate action is taken, Garoua's greenhouse gas (GHG) emissions could increase by 40% over the next decade. Since Garoua wants to limit its contribution to GHG emissions by reducing emitting activities, the mitigation pillar of its SEACAP focuses on transforming these key sectors.

The SEACAP will also provide a roadmap for ensuring affordable and sustainable energy for citizens while preserving the environment. In addition to guiding energy planning and development initiatives in the energy sector, Garoua has the capacity to attract private sector investment as the SEACAP demonstrates the city's solar energy potential. This includes new business opportunities with solar panels, biodigesters and clean cooking technologies. While statistics show that Garoua has good energy access figures, with 62% of households connected to a clean grid that uses mostly renewable energy, the city aims to reach 90% electricity access by 2030. Increasing on-grid and off-grid power generation and extending the existing grid to unserved areas are concrete action points already defined. "Through the SEACAP development process, Garoua has demonstrated its capacity and willingness to lead climate action in Cameroon by setting ambitious targets to reduce its GHG emissions, adapt to the impact of climate change, and improve access to clean, sustainable and affordable energy in the region. The next steps will be to turn these plans into actions and identify projects to further develop these proposals. The CoM SSA initiative will continue to support Garoua in maturing projects to a more bankable stage, by helping local governments identify financing mechanisms and investors," said the **2nd Deputy Mayor of the Urban Community, Mr. Hakassou Noivouna**.

Figure 11: The Mayor of the City of Garoua and Staff of its three subdivisional councils (Garoua I, II and III)[141]

Tool #2: Institutional Framework in Place

Cameroon has ratified numerous international conventions, including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the United Nations Convention on Biological Diversity (UNCBD), and the United Nations Convention to Combat Desertification. (UNCCD). These conventions were transformed into national implementation plans.

Policy Framework: In accordance with its National Climate Change Adaptation Plan (PNACC - Plan National d'Adaptation au Changement Climatique), Cameroon created its Intended Nationally Determined Contribution (INDC) in December 2015 under the auspices of the UNFCCC. According to the PNACC, "climate change is fully incorporated into the nation's sustainable development, reducing its vulnerability, and even turning climate change into a solution/opportunity for development." As a result, Cameroonians, especially women, children, and defenceless individuals, as well as the nation's economic sectors, are more resilient and adaptable to the effects of climate change. The PNACC's overarching goal is to help Cameroonians adapt to climate change by lowering their susceptibility to its effects, raising their level of resilience and quality of life, and enhancing their capacity for adaptive growth to open new opportunities for the nation's sustainable development. In order to achieve this, the Plan has the following four strategic goals: (i) increase awareness of climate change in Cameroon; (ii) inform, educate, and inspire the population to adapt to climate change; (iii) lessen vulnerability to climate change in the nation's major sectors and agro-ecological zones; and (iv) incorporate adaptation to climate change into strategies and national sectoral policies.

141 The City of Garoua and its three subdivisional councils (Garoua I, II and III) on the launching of the city's Sustainable Energy Access and Climate Action Plan (SEACAP), a vast climate action programme for the 2030 horizon.

In accordance with the second National Biodiversity Strategy and Action Plan (NBSAP II) within the framework of the UNCBD, Cameroon aims to create a sustainable relationship with its biodiversity by 2035 through a sectoral and decentralized integration and the effective participation of all stakeholders, including local authorities, to meet the needs of development and the wellbeing of the population as well as to preserve the health of its ecosystems.

The Cameroon Vision 2035, the National Agricultural Investment Plan 2014–2020 (PNIA – Plan National d'Investissement Agricole), the Strategic Document for Growth and Employment, the National Gender Policy 2011–2020, the Strategy of Woman and Family Promotion, the Youth National Plan, the Sectoral Programme Forest, and Environment (PSFE II – Programme Sectoriel Forêt et Environnement), etc. are some other important policies regarding the project.

The National Development Strategy of Cameroon is built around four major foundations. [142] The first pillar, which deals with the fundamental transformation of the national economy, is concerned with economic planning that will aid in the resolution of specific issues. Inadequate structuring and productivity of Family Farms (EFA) in rural areas (while specifically targeting determinants and factors of production); productive infrastructure whose priorities must be clearly defined; low levels of industrialization; weak upstream and downstream intersectoral linkages; inadequate targeting of Family Farms (EFA) in rural areas. Since the goal of emergence is to transform the nation into a Newly Industrialized Country (NIC), the development strategy for industries and services serves as the foundation upon which other sector-based strategies were developed.

The second pillar focuses on the development of human capital. In order to create a workforce that is more productive, it tackles sectoral strategies with a social emphasis (health, employment, social protection, education, etc.). From this angle, the government's action fits into a logic of ongoing social policy improvement, in accordance with endogenous growth theories that assert that most of the growth would result from the fusion of technological innovation and well-trained human resources.

The third pillar deals with youth inclusion in the economy and employment promotion. In more detail, it addresses the problem of underemployment, matching work, and training requirements with a focus on customizing training to meet the needs of the productive sector and assisting businesses in the sector. The goal is to create a framework that is efficient for the emergence of most job-creating businesses, such as SMEs, cooperatives, and the social economy in general. In order to maximize the use of human resources, special focus will also be given to controlling the labour market.

[142] https://effectivecooperation.org/system/files/2022-01/NATIONAL_DEVELOPMENT_STRATEGY_2020_2030.pdf

The fourth pillar focuses on state administration, decentralization, and governance. The third component of Vision 2035, "unity in diversity," which is in addition to conventional aspects, is centred on problems relating to local development, multiculturalism, and bilingualism.

Tool #3: Stakeholder Engagement

In Cameroon, the stakeholders identified for effective renewable energy were the local management committees, microfinance organizations, non-governmental organizations (NGOs), renewable energy enterprises (REEs), and universities.

The administration, operation, and upkeep of installed systems, as well as the revenue collection based on fee-for-service tariffs, must be handled by local management committees.

In accordance with predetermined monthly energy expenditures, microfinance organizations should grant loans to communities for the purchase of commercially and economically viable off-grid renewable energy systems.

NGOs are expected to offer technical support in the development of community projects, in obtaining money from cooperation partners, and in seeing that projects are carried out. Equipment for generating green energy should be sized, installed, and maintained afterwards by REEs.

Universities are responsible for training the techs and engineers that NGOs and REEs will employ. The first Department of Renewable Energy at the University of Maroua was established in 2008 in recognition of this important function by the government of Cameroon.

In his article, C. Iaione explores whether urban resources and assets may be turned into ecosystems that encourage cooperation, sharing, and commoning, and permit collective actions for the commons. To him, this can be achieved by switching from closed, centralized institutions to co-owned, co-managed, and co-produced institutions for the governance of urban resources as commons so that the community can reap the benefits. His analytical framework is based on a few key components that are still missing from urban governance schemes: organizational innovations within city administrative structures, a communication strategy using a democratic digital platform as the primary tool, and bridging institutions that spread commoning culture and practice at the city level and in neighbourhoods. C. Iaione also recommends that cognitive institutions like schools, universities, and policymakers need to have their roles rethought and function as facilitators rather than authorities or producers of specialist knowledge.[143]

[143] C. Iaione, The CO-City: Sharing, Collaborating, Cooperating, and Commoning in the City. American Journal of Economics and Sociology, 2016, vol. 75, issue 2, 415-455

Tool #4: Litigation Related to Climate Change: Implementation Challenges

In the absence of climate change litigation cases in Cameroon and Ghana, this work analyzed the transnational litigation and climate change in Nigeria. Numerous domestic, regional, sub-regional, and international tribunals around the globe have heard cases involving climate change.

The 169 targets and 17 lofty goals known as the Sustainable Development Goals (SDGs) are intended to promote sustainable development. Through international institutions like the 1992 UNFCCC, the 1997 Kyoto Protocol, and the 2015 Paris Agreement on Climate Change, international law has become increasingly important in supporting regional and domestic initiatives for climate action. Non-state actors, particularly multinational corporations (MNCs), are crucial to the international framework for addressing climate change, and victims and their advocates have turned to climate litigation as a key tactic to control how businesses affect human rights and the environment in communities that produce oil and gas. This part focuses on Nigeria's chances of achieving SDG 13 in specifically through international litigation.

A human rights perspective on climate claims is developing on a global scale. In Pakistan, a judge accepted defenses that the petitioners' rights were violated by the government's inaction on climate change.

In Urgenda Foundation v. State of the Netherlands, the Dutch Supreme Court ordered the government to reduce greenhouse gas pollution by 25% below 1990 levels by 2020 in the Netherlands.[144] This has never happened before in any country or region. The appropriate stakeholders use transnational climate change litigation to make African nations and MNCs answerable for the impacts of climate change and associated human rights violations.

In Milieudefensie et al. v. Shell,[145] the District Court of The Hague ordered Royal Dutch Shell to cut down CO_2 emissions by 45% by 2030. Citing the UN Human Rights Committee and the UN Special Rapporteur on Human Rights, the court emphasized the value of a human rights strategy in cases involving climate change.

As a deliberate tactic to sway the actions of the government and multi-national companies (MNCs) in the oil and gas industry, Civil Society Organizations (CSOs) in Nigeria have turned to litigation. The results of a successful lawsuit may result in the creation of new regulations. The rise in cases brought overseas, mostly in the home states of MNCs, is indicative of the growing reliance on transnational litigation to hold MNCs accountable for environmental degradation and human rights violations in Nigeria. These cases demonstrate the methods local communities use to pursue judicial

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[144] For more information, see http://climatecasechart.com/non-us-case/urgenda-foundation-v-kingdom-of-the-netherlands/

[145] See http://climatecasechart.com/non-us-case/milieudefensie-et-al-v-royal-dutch-shell-plc/

enforcement of their contracts with MNCs outside of Nigeria as well as the potential judicial remedies open to host communities that experience environmental injustice.

Kiobel v Shell[146] is a class action that was based on the defendant's alleged complicity in the state's crimes committed against the Ogoni people.

A class action lawsuit called Akpan v. Shell[147] was filed against Shell in the Netherlands based on claims that Shell was responsible for years of oil pollution in three Niger Delta communities. The court dismissed other allegations of a general duty of care against the defendant but found that the defendant was responsible for compensating losses arising from two specific oil spills from an abandoned wellhead. These examples serve as a reminder of the value of class actions in defending the human rights, including environmental rights, of people and communities impacted by the actions of multinational corporations engaged in the oil and gas sector. Non-state actors are also actively involved in promoting victims of MNC human rights abuses' access to justice.

As evidenced by a ruling of a civil court in the Hague requiring Shell to reduce its CO_2 emissions by 45% compared to 2019 levels, climate change litigation has the potential to compel relevant players towards more ambitious climate action. Damages for the violations caused by multinational companies are the final relief sought by the parties in the cases under consideration, but this does not further the achievement of SDG 13. Foreign courts cannot force the Nigerian government to control the operations of multinational companies in a way that advances SDG 13 and other goals related to human rights and environmental protection, nor can they ensure the enforcement of their judgments in Nigeria. Therefore, it cannot be overly depended upon to advance SDG 13/climate change or human rights in Nigeria through litigation of related claims by the victims in foreign courts. A global treaty for the international enforcement of judicial judgments in climate change cases could be investigated to increase the efficiency of climate change litigation.

Tool #5: Energy Transition Projects

A) Energy Projects in Cameron:

i) The Nachtigal Hydropower Plant

This is a key project in Cameroon. The project site is located 70 km northeast of the capital Yaoundé. The dam, built on the Sanaga River, will be 1.455 km long and the headrace channel will be 3.3 km long. With an installed capacity of 420 MW, Nachtigal will be the most powerful electricity-generating facility in Cameroon when it is commissioned. The development, construction and

[146] See https://www.law.cornell.edu/supremecourt/text/10-1491

[147] See https://www.studeersnel.nl/nl/document/maastricht-university/corporate-social-responsibility/summary-akpan-vs-shell-judgement/3565231

operation of this hydroelectric scheme is the responsibility of the Cameroonian company Nachtigal Hydro Power Company (NHPC), which is 40% owned by EDF. The Project is estimated to cost 1.2 billion euros and its Commissioning date is in 2024. The Project is 30 % of Cameroon's electricity production.

Figure 12a:[148] Dam under construction: Channel intake, spillways, and temporary diversion – April 2022

Figure 12b: Hedrace channel under construction: Headrace channel: laying the bituminous lining – April 2022

Figure 12c: Energy production plant under construction: Plant (7x60 MW Units) – April 2022

[148] Sources of Figures 12a, b, c, d: EDF Cameroon

Figure 12d: 225kv transmission line completed: Evacuation station (foreground) – Evacuation lines to Nyom 2 station (background) April 2022

EDF supports Société Générale in its energy efficiency initiatives

EDF signs a contract with Société Générale Cameroun to install a customised solar solution to power the country's main bank branches. This initiative will reduce carbon emissions by around 2,000 tonnes, which corresponds to "almost 12,000 trees planted in Cameroon". This initiative by Société Générale Cameroun also contributes to the diversification of the country's energy mix, which is still largely dominated by hydroelectricity and thermal energy. Solar, biomass, and wind power still represent barely 1 % of the energy mix.

ii) Kikot Hydroelectric Scheme

EDF signed a development agreement with the Government of Cameroon on 25 June 2021 for a second major hydroelectric project, the Kikot project. The two partners are jointly developing the project. The site, located 60 km northwest of Yaoundé on the Sanaga River, is on the border between the Central and Coastal regions.

Local presence for an environmentally friendly project: The project includes a dam and its water reservoir, as well as a hydroelectric plant. The plant, with a capacity of between 450 and 550 MW, will be the most powerful in Cameroon. The planned schedule is ambitious, aiming for construction to start in 2025 and commissioning in 2029. A dedicated team from EDF Cameroon is fully engaged in the Kikot project. It is based in a recently opened office closest to the project site, in the community of Evodoula. This allows it to work in close contact with the local population.

As part of carrying out the preliminary design (APS), environmental, societal and technical studies are underway. They will enable us to design a sustainable and efficient project that respects the environment and the people.

Figure 13: Kikot Hydroelectric Scheme[149]

The Memorandum of Understanding was signed on November 26, 2019. On June 25, 2021, the development agreement with the Government of Cameroon was held. 2022 – 2024 Environmental and technical research; business setup and closing. The construction is expected to begin in 2025. The power plant will be put into service in 2029. The power system is not linked to 45% of the population. In Cameroon, 2.3 million households lack access to electricity. 15 years of off-grid experience. 1 million consumers who are off the grid by 2030.

iii) Cameroon Rural Solar Project

Huawei Technologies Co. Ltd. carried out the rural solar project in Cameroon in two stages with the aim of supplying power to rural communities in all ten regions of the national territory. However, the Far North Region was excluded from the first phase due to security concerns brought on by the resurgence of Boko Haram. The implementation of this initiative in the English-speaking North West and South West Regions have been considerably impacted since 2016 by the political instability in these two regions. Commercialization and maintenance activities were suspended in the First Phase at the 25 locations built in the English-speaking North West and South West Regions due to security concerns and political upheavals. Due to security concerns in the two regions, work on the second phase of the project was put on hold, and a "Prime Ministerial decision" was issued to make provisions for the relocation to the eight French-speaking districts. Theft and vandalism of equipment, poor maintenance, and abandonment of areas with overgrown vegetation are all difficulties this initiative must deal with.

[149] *Ibid.*

iv) Independent Solar Kits

2020 saw the launch of 300 solar systems made by the German company Solarworx thanks to a partnership between EDF and upOwa and Solkamtech, two Cameroonian businesses that specialize in the distribution of standalone solar kits. Promoting sustainable energy to homes and businesses outside the distribution network is the goal of this experimental initiative.

v) Mini-Grids

Mini-grids are technical ways to increase people's access to energy in areas where the electrical grid is not present. In Cameroon today, around 45% of the population lacks access to electricity. Supporting the government and local authorities in their electrification efforts is one of EDF's goals. EDF intends to develop, construct, and run a variety of renewable energy-generating facilities outside the electrical grid (solar, biogas, hydroelectric). Below are the RE Technologies in Cameroon:[150]

a) Hydropower:

Hydroelectricity is a low-cost, renewable, non-polluting energy source that helps Cameroon's economy and society grow. Cameroon currently has three hydropower production dams: Songloulou (387MW installed capacity), Edéa (263MW installed capacity), and Lagdo River Benoué (72MW installed capacity), with three other dams dedicated to bolstering the Edéa and Songloulou plants. Cameroon ranks third in Sub-Saharan Africa in terms of hydropower potential, behind the Democratic Republic of the Congo and Ethiopia. The Mbakaou on the Djerem, the Bamendjin on the Noun, and the Mape on the Mbam are these three retaining dams. The government intended to build 2500 MW of capacity between 2012 and 2020, including 298 MW of thermal capacity, to meet the rising demand. The government intended to build 2500 MW of capacity between 2012 and 2020, including 298 MW of thermal capacity, to meet the rising demand. Lom Pangar (170 MW), Natchigal (280 MW), Song Dong (280 MW), and Menve'elé (200 MW) are a few more dams that are now being built.

b) Biomass:

Cameroon, which employs more than 60% of its population and covers three-quarters of its land with 25 million hectares of forest, has the third-largest biomass potential in Sub-Saharan Africa. Agricultural waste, wood waste, and animal waste are a few examples of biomass. Agriculture and forestry account for a major portion of Cameroon's biomass potential. Particularly in rural Cameroon, the widespread use of biomass energy for cooking, heating, and lighting has led to extensive deforestation, which raises carbon dioxide emissions and consequently contributes to global warming. Both the domestic (about 75% of residential energy consumption) and industrial (about 90% of energy

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150 https://centurionlg.com/2022/02/07/renewable-energy-plans-in-cameroon-2/

demand) sectors in Cameroon utilise biomass energy sources. Despite the country's huge forest reserve, improper use of this potential has led to considerable rates of deforestation nationwide.

c) Solar Energy:

With the highest values in the far north, the daily solar radiation averages between 4.5kWh/m2/day in the south and 5.7kWh/m2/day in the north. Germany, which only uses 1.7 kWh/m2/day on average, has more than 40 000MW of solar energy installed. In other words, Cameroon has considerable solar potential. There are currently plans to take advantage of solar energy, which has not been fully used.

d) Wind Energy:

Cameroon has an inadequate potential for wind. The Mount Bamboutos region of Cameroon has the capacity to generate about 400MW using proven resources. More importantly, Cameroon has a great deal of potential for creating off-grid solutions that can help with electrification using cheap and clean energy sources in a short amount of time. Despite the government's efforts to utilize these places, this area is likewise not thoroughly explored.

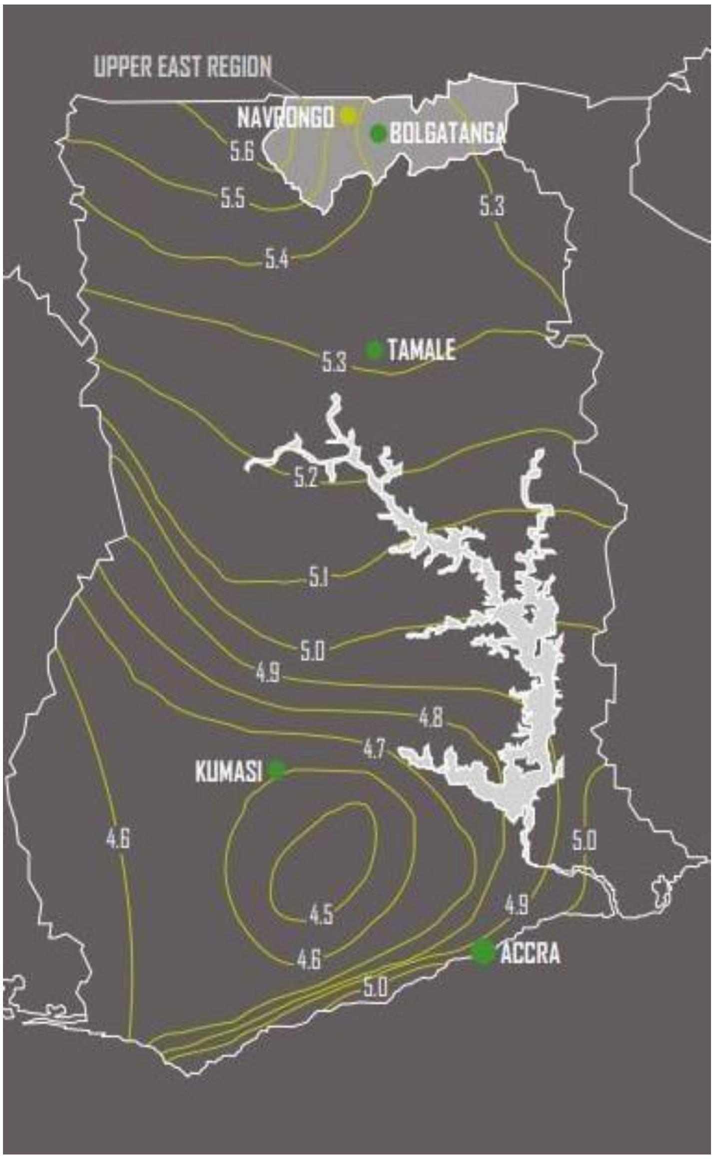
B) Ghana Renewable Energy Projects: Navrongo Solar PV Project

The Navrongo solar PV project was one of the first utility-scale PV plants in Ghana and was completed in 2013. During this time, the country was experiencing rapid economic expansion but lagged in the installation of new power capacity, making a lack of generation capacity appear to be the main sector planning worry.

It is important due to its demonstration effect and as a replacement for expensive thermal power generation. Currently, the plant feeds 3.8 GWh annually into Ghana's national power grid, which is run by Ghana Grid Company (GRIDCo) and off taken by Northern Electricity Distribution Company (NEDCo). The project site is located less than 10 km from the country's northern border with Burkina Faso.

The Volta River Authority (VRA) is Ghana's leading parastatal power generation business in Ghana and is the owner and operator of the Akosombo hydro plant. The project was part of VRA's 2010-created Renewable Energy Development Programme (REDP). It includes 150 MWp of wind energy near the VRA Akosombo plant and 14.5 MWp of PV at three to four sites in Ghana's northern region. VRA has hired Lahmeyer International, a German engineering firm, as the owner's engineer for the REDP in general and Navrongo in particular. The land is less expensive in northern Ghana than it is close to the main load centres of the nation, which was another factor in choosing the isolated locations.

Figure 14: Solar Radiation Map of Ghana (kWh/m²/day) adopted from ECREEE case study Navrongo Solar PV Project Ghana



VRA completed the procurement procedure in Ghana and recruited Lahmeyer International to carry out an environmental analysis. In late 2012, the project received Clean Development Mechanism (CDM) approval as part of a multi-country Programme of Activities (PoA) created by the UK-based Standard Bank.[151] Unfortunately, one of the earliest CDM projects in Ghana was abandoned due to the decline in CER prices in 2012.

In late 2012, the project received Clean Development Mechanism (CDM) approval as part of a multi-country Programme of Activities (PoA) created by the UK-based Standard Bank.3 One of the earliest CDM projects in Ghana, was abandoned because the anticipated revenue from CER sales was so low due to unlucky timing (the decline in Certified Emission Reduction (CER) prices in 2012, when carbon credits lost 90% of their value).

The Navrongo plant has been running since February 2012 and produces 3,800 MWh of energy annually.[152] The generation was 3,843 MWh in 2014 (VRA 2015). The quality is acceptable with high cabling, mounting, and civil works, and the modules, grid connections, control room, and VRA on-site staff adhere to international standards. However, there were some simpler problems that could have been resolved such as small animals entering the perimeter, the module rows and plant surroundings lacking a path for easy inspection and maintenance, and the lignite used for ground coverage producing additional dust that could settle on the PV modules.

The primary economic benefit of PV injection is the savings of thermal fuel. Additional advantages such as jobs, a decrease in energy prices, and avoided carbon emissions are smaller.

[151] For more information on the "Standard Bank Renewable Energy Programme" please visit https://cdm.unfccc.int.
[152] The first phase (1.9 MWp) was commissioned in February 2012, and an additional 600 kWp was commissioned in June 2013.

Navrongo was the first utility-scale PV plant in Ghana, and the energy pumped by the plant is valued between 0.15 and 0.35 USD/kWh. With an average cost of 0.20 USD per kWh, the annual return is approximately 760,000 USD. For investors with WACC up to 15%, the initial investment would be closer to USD 5 million at the lower PV CAPEX of today, which is roughly 2 USD/Wp (installed in Ghana).

The project's primary environmental advantage is the impact on the global climate from replacing thermal fuel with PV energy. Additional carbon savings could be possible if the Akosombo or Bui hydropower plants were operated with a higher evening load. The CDM PoA suggested annual carbon savings of 1,074 tons of CO_2, which is supported by recent analyses of the actual carbon avoided at optimal national dispatch.

The BPA Act 740, which created the Bui Power Authority, set out to use natural resources for electricity generation in a safe, cost-efficient manner in order to foster socio-economic development. The Bui Power Authority (Amendment) Act 2020, Act 1046, granted the Authority the legal authority to carry out clean energy alternatives, carry out its own renewable energy operations, and carry out projects involving renewable energy on behalf of the State. In order to accommodate and evacuate 250MWp of solar power for the construction of a hydro-solar PV hybrid (HSH) system within the Bui enclave, the Bui Switchyard was extended as part of the Government of Ghana's attempt to boost the proportion of renewable energy in the energy mix by 10% by 2030. This will be the first hybrid power plant in Ghana to produce and supply electricity to the national grid using both solar and hydropower sources.

In October 2019, BPA connected the 50MWp solar PV facility to Ghana's National Interconnected Transmission System (NITS) by commissioning the facility, a control room, and a transmission system. A 1MW floating solar plant was also put into operation in the sub-region and relayed to the NITS via the BUi Switchyard. The location of substations in the North where possible solar projects can be connected to the NITS has been explored by BPA and GRIDCo. For these initiatives, BPA has chosen six locations: Bawku, Yendi, Tumu, Sawla, Buipe, and Zebilla. The benefits of the projects include:

- Support for the government's initiative to boost renewable energy's share of the energy mix by 10% by 2030. as a component of the country's National Determined Contribution (NDC) to the UN Framework Convention on Climate Change (UNFCC).
- The creation of jobs for Ghanaian workers, both skilled and unskilled. The Bui Generating Station Project Affected Persons and other predicted affected persons at our various sites have also been offered employment chances.
- Establish a hydro-solar PV hybrid system to aid in the preservation of the Bui reservoir.

- Providing clean energy, which mitigates climate change.
- Increasing the number of families with access to electricity would help to ensure reliable and affordable power.

C) Nigeria Energy Projects

i) Hydro Project: Mambilla Hydropower Project

A 3.05 GW hydroelectric facility known as the Mambilla Hydropower Project is now being built on the Dongo River close to Baruf in Kakara Village, Taraba State, Nigeria. With the aid of Chinese investments, the project is being carried out by Nigeria's Federal Ministry of Power, Construction, and Housing. Mambilla, which is anticipated to start operating in 2030, will be Nigeria's largest power plant and produce about 4.7 billion kWh of electricity annually. Up to 50,000 local jobs will be created throughout the building phase of the $5.8 billion project.

The Mambilla hydroelectric complex consists of two subterranean powerhouses, four underground dams, and a total of 12 turbine generation units. For the Mambilla hydroelectric project, four dams will be built on the Dongo River: the Nya (formerly known as Gembu), Sumsum, Nghu, and Api Weir dams. Four 500kV DC transmission lines linking Makrudi and one 330kV DC transmission line connecting Jalingo will carry the Mambilla hydropower facility's output to the national grid.

ii) Renewables: 1mw Interconnected Mini-Grid

The Abuja Electricity Distribution Company (AEDC), Green Village Electricity (GVE), and the Wuse Market Association have signed a tripartite agreement for the construction of a 1 MW interconnected mini grid at the Wuse market in sub-Saharan Africa. This project is part of the Energizing Economies Initiative and aims to provide SMEs with clean, reliable, and inexpensive electricity. It will use 3 independent hybrid PV solar systems with a combined capacity of 450kWp, 350kWp, and 200kWp to service 3 different market segments in the Wuse region. Over 2,000 Small and Medium Scale Enterprises will be provided with uninterrupted power because of the project, which will also promote economic expansion.

iii) Nuclear Energy

The Federal Government of Nigeria (FGN) established the Atomic Energy Commission (NAEC) as the focal promotional institution to provide the technical leadership to achieve this national goal in recognition of the need to enhance the nation's national electricity supply and investigate the potential of nuclear energy. The NAEC created a technical framework and approved a Strategic Plan for the Implementation of the National Nuclear Power Program in Nigeria in 2009, which will lead to the commercial operation of the first NPP by 2025.

iv) Rural Electrification Projects

The Nigeria Rural Electrification Agency (REA) is in charge of giving rural residents access to a steady supply of electricity. The Electric Power Sector Reform Act of 2005 created the Rural Electrification Fund (REF) to encourage the growth of the on- and off-grid sectors. The program's objectives were to ensure that energy services were accessible and reasonably priced while also rapidly expanding access to electricity in rural areas. Due to rising demand and population, just 26% of rural households have access to power. The Federal Government of Nigeria (FGN) has pledged to spend NGN 317.8 billion and NGN 525.8 billion annually to achieve 75% electricity access by 2020 and 100% by 2040, respectively. The FGN, other Nigerian government agencies, power providers, international donors, commercial banks, RE scheme operators, and equity investors are just a few of the sources from which funding and investment will flow. Operation Light-Up Rural Nigeria has been modified by the Federal Ministry of Power to include the Renewable Energy Micro-Utility (REMU). Through the development of renewable energy resources in Nigeria, REMU serves as a Sustainable Platform for Integrated Economic Empowerment (SPIE). Over 6,000 Standalone Solar Home Systems were deployed to off-grid communities by REA in 2020, along with the completion of 7 mini-grids. The Nigeria Electrification Programme supports the goals of the Power Sector Recovery Plan (2017–2021) goals to enhance private investment in the energy industry, particularly the deployment of off-grid/mini-grid energy services and rural energy access and is in line with the Rural Electrification Strategy and Implementation Plan.

Some of the programs currently being implemented are: the Solar hybrid mini-grids; the Minimum Subsidy Tender for Solar Hybrid Mini-Grid; Standalone Solar Home Systems for Households and MSMESs; and the Energizing Education Programme II & III.

3.9 Data Collection and Analysis through Interviews

A qualitative research technique known as an interview relies on the collection of data using questions. Two or more persons participate in interviews, one of them is the interviewer who asks the questions, and the interviewee who responds to the questions.

There are various interview kinds, which are frequently distinguished by their degree of structure.

However, this study’s collection and analysis of qualitative data involved the use of both structured and semi-structured interviews (one-on-one interviews with relevant stakeholders). In contrast to a traditional interview procedure, structured and semi-structured interviews use an organized set of questions that are asked in a predetermined order and are relevant to research themes

(Saunders et al., 2019). It introduces a new subject, however, if a new query appears before it (Cachia and Millward, 2011). Depending on the research design, semi-structured interviews were performed via Zoom, video chats, and in-person meetings and lasted anywhere between 30 and 60 minutes. The tool for this research was chosen to be a two-way communication mechanism that enables the exchange of information in a discursive manner (Braun and Clarke, 2006). As a result, participants and researchers can uncover fresh and previously undiscovered information while also advancing their hunt for significant information (Braun and Clarke, 2006). The interview questions were taken from other research projects with comparable goals and objectives.

i. Participants

The selection of the stakeholders was made based on their status as pertinent stakeholders in this situation. The relevant stakeholders are interviewed to further examine and assess the government's preparedness to address the effects of climate change on the energy sector and to offer additional recommendations on how to improve climate governance. Participants in the interview included:

- A municipal official at the local government level from Garoua, Cameroon
- Two private actors in the energy sector from Ghana and Nigeria
- Two academics from research institutions from Ghana

According to research ethics, agreement from potential participants was only requested after they had been fully informed of the study's purpose, the format and model of the interview, the intended use of the data, and an ethical statement. To protect their privacy, a few participants agreed to be recorded but objected to having their identities revealed. Each interview was taped with the participant's express consent to aid in transcribing and analysis. The researcher can concentrate her questions and attention on the interviewee while the video is being filmed, which is an extra benefit.

ii. Data Analysis

Prior to manually entering the data into a Word document, the qualitative theme analysis method was used to review the acquired data. This analysis involved a multi-stage process. As a first step, data transcription is done to familiarize oneself with the information being transcribed. Data-driven coding for raw data was also developed. The key findings resulted in highlighting and splitting into the different countries' case studies. The points were subsequently evaluated in detail, and the data they contained was reviewed.

CHAPTER 4

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Research Findings

4.1.1 Findings in CAMEROON

i) Barriers to RE development

The primary energy source in Cameroon now is renewable energy, which is also used to power the country's residential sector (which still relies on conventional biomass cooking techniques). RE has the potential to supply a large amount of the energy needed by the transportation, industrial, commercial, and agricultural sectors if used effectively. Despite the potential of RE to meet the nation's energy needs, the success of RE has been limited by a combination of three primary concerns, namely, policy and legal, technical, and financial issues. Cameroon's hydroelectric sub-sector has seen considerable investment trends, but the country lacks a defined regulatory and legislative framework for the growth and promotion of RE. There is a lack of RE Technology (RET) expertise as well as a labour scarcity that prevents the successful spread of RE. Major financial barriers to the successful implementation of RE projects include a lack of low-cost, long-term financing options, a lack of stakeholder understanding of RE financing mechanisms, as well as the exorbitant costs of RET for the poor population.

ii) The Absence of Cogent Strategic Aims, and the Sector's Financial Stability

Due to SONATREL's complete operationalization, the absence of cogent strategic aims, and the sector's financial stability, the electricity sector in Cameroon is experiencing difficulties. The structure and development of the generation capacity contribute to the uncertainty around power generation. A new strategy is required to coordinate and direct future investment, including the assessment of a deeper introduction of gas, to address this. Furthermore, mechanisms and structures must be established to link the master plan to phased project implementation and promote the priority investments outlined in the updated plan in an organized, open, and competitive manner.

iii) Climate Change

Due to climate change, recent drought occurrences have highlighted the need for better planning and management of hydroelectric plants. The Lagdo dam's output has been badly damaged by the water shortage in the Benoué basin, resulting in low generation for the entire first semester of 2021. This has led to the deployment of about 30 MW of gensets as part of an emergency plan to supply electricity to the North, raising the cost of energy and CO_2 emissions. SONATREL's complete operationalization, the GoC's mobilization of counterpart funds, the expediting of the compensation decrees process, and the transfer of project payments into foreign accounts are additional hurdles. To reduce the cost of supply, access policies must concentrate on rehabilitating and expanding distribution networks as efficiently as possible.

iv) The Lack of Availability in Rural and Low-income Areas

Due to the lack of availability in rural and low-income areas, Cameroon, an SSA country, is experiencing financial difficulties. As ENEO will not be able to pay or obtain financing for unprofitable access programs, it must concentrate on safer and higher-income areas to reduce negative effects and the possibility of a lack of subsidies. By reorganizing its debt and advancing its ten-year investment plan, ENEO must address its liquidity issues to maintain its financial survival. The GoC and state-owned businesses are heavily in debt, which puts financial strain on ENEO. The GoC issued treasury bonds in 2020 to pay off XAF 45 billion of its overall arrears. There is a need to assist ENEO in hastening the implementation of its strategy as just 100 billion XOF of the 521 billion needed has been raised as of 2021.

4.1.2 Findings in GHANA

i) The Potential of Solar Energy in Ghana

Ghana has a high potential for solar energy generation due to daily solar insolation values of 4 to 6 kWh/m2 and annual sunlight durations of 1800 to 3000 h. The Solar Wind Energy Resource Assessment (SWERA) study for Ghana provides additional confirmation of these statistics. However, obstacles such as lack of political will, technical know-how, components, funding, and land have slowed the sector's expansion. Gyamfi et al.'s study showed that 90% of all renewable energy installations in Ghana are solar energy installations. Energy policy, technological viability, equipment supply, manufacture, and finance of solar energy use are barriers to its use.

ii) Challenges

Most stakeholders who participated in the interview in this research manifested their grievances regarding the power sector in Ghana which is faced with a few difficulties, such as insufficient infrastructure for power supply that requires significant investment, an overreliance on hydro and gas, poor access to electricity, expensive fuel used to generate electricity, transmission and distribution losses, insufficient regulatory capacity, enforcement issues, operational and management issues, and vulnerability to climate change. The quest for cleaner energy and the growing living standards of Ghanaian citizens provides significant obstacles to future power development.

iii. Limited Generation Capacity of Power Plants

Ghana's power supply difficulties are caused by unpredictable patterns of rainfall and inflows into hydropower plants. The country is forced to rely on oil and gas-fueled thermal power plants due to restricted water inflows, which cannot operate at full capacity, as well as due to the scarce and expensive fuel supply.[153] With outdated infrastructure and a precarious financial situation, VRA, the Electricity Company of Ghana (ECG), and Ghana Grid Company Ltd. (GRIDCo) are all contributing to blackouts. The Tema Oil Refinery's processing capacity has remained unchanged, making it unable to import and process enough crude oil to meet demand.[154]

iv. High Cost

Most energy firms in Ghana are state monopolies, responsible for energy production, transmission, and distribution, but they are facing high costs due to lack of funding and investment, shoddy infrastructure, inadequate performance, and poor administration.[155] Frequent power outages are caused by overloaded transformer sub-stations, transmission and distribution losses, and transmission bottlenecks. Current hydroelectric plants have maintenance and capital expenditures, which are financed by the sales of energy.[156] To meet demand, it is necessary to build additional plants, which will increase costs and lower system returns. The high cost of technology to generate renewable energy sources is another cost factor.

v. Sustainability

The Ghanaian power sector needs competitively priced energy to be financially viable, and the government spent $900 million on fuel subsidies to VRA in 2004. However, due to their failure to maintain and build the necessary infrastructure, the transmission and distribution agencies (VRA and ECG) are in a financial situation. To keep the cost of supply as low as possible while preserving the sector's financial viability, the operational and production effectiveness of the sector's authorities is essential.

vi. Growth and Development Implications

The current low rates of electrification in Ghana are having a negative impact on the country's economic expansion and development. An energy supply increase is necessary for economic expansion, and studies have shown that there is a causal relationship between economic growth and energy use (Vlahinic-Dizdarevic and Zidovic,[157] Amiri and Zibaei,[158] Jumbe[159]). Technology cannot be used for production without power, and electricity is required by tertiary firms for lighting, heating, cooling, and running computers and office machinery. Without electricity, the infrastructure that supports development will crumble, and businesses and sectors choose to insure themselves against

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[153] This information was expressed by most stakeholders, and participants in the interview, particularly the local citizens, a PhD researcher in Economics, as well as most private actors in the energy sector in Ghana.
[154] Ghana Wholesale Power Reliability Assessment (2010) Final report. Power Systems Energy Consulting, GRIDCo.
[155] Energy Sector Strategy and Development Plan (2010) Ministry of Energy. Ghana.
[156] *Ibid.*
[157] Ghana Grid Company Limited (GRIDCo) (2010) Annual report.
[158] Energy Commission (2015) Energy supply and demand outlook for Ghana. Energy Commission.
[159] *Ibid.*

outages by investing in expensive generators and plants. Unreliable power supplies and outages have significant financial costs, and electricity has become the preferred power source for usage in the home.

vii. Energy Sector Initiatives and Power Sector Reforms

The World Bank and the International Development Association (IDA) have played a significant role in power sector reforms over the past four decades. The IDA has helped Ghana improve its distribution networks, finance the Akosombo Dam and the Kpong Power Plant, repair transmission systems, extend the grid to the northern regions, and provide electricity to small urban areas, district capitals, and rural areas.[160] The 2008-established Electricity Regulation was created to develop a competitive wholesale electricity market and support Ghana's efforts to reach a 5000 MW electricity generation capacity by that year.

As per research, the power sector in Ghana has benefited from donor funding since 1960 to provide better energy services. The Structural Adjustment Program of 1986 demanded improvements in Ghana's power industry to promote increased private sector engagement.[161] In 1994,[162] the power sector underwent reform to de-regulate the market for competition and allow access to transmission lines. Research shows that in 2006, the Ghana Grid Company Ltd (GRIDCo) was founded to make it easier for electricity to be transmitted. Also, in 1997, the Public Utility Regulatory Commission (PURC) and the Energy Commission were established to create and sustain a competitive, healthy power sector. The Electricity Regulation was established in 2008 to develop a competitive wholesale electricity market and foster an atmosphere that would draw independent power producers. This was done to support Ghana's efforts to reach a 5000 MW electricity generation capacity by that year.

The National Energy Policy (2010) is being implemented to give the public information about the government's policy goals and objectives, to promote the successful management and growth of the sector, and to provide a clear picture of the policy direction, challenges, and actions of the government. The policy targets the poor quality and inconsistent supply of power as well as the utility companies' inadequate financial performance and assists them in obtaining the funding required for infrastructure expansion. The policy also emphasized building institutional and human resource capacity, developing a competitive energy market, and creating an environment that will encourage private investment in the industry and support the government's multilateral funding sources.[163] Ghana must raise its installed power capacity to 5000 MW by 2016 in accordance with the National Energy Policy (2010),[164] which aims to install an additional 2100 MW of installed capacity by 2016. However,

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[160] Ghana Growth and Development Platform (2015) Of "Dumsor" and Ghana's energy sector challenges: Part 3 http://ghanagdp.org/. Accessed 3 July 2015.
[161] See footnote 154.
[162] See footnote 157.
[163] National Energy Policy (2010) Ministry of Energy, Ghana.
[164] *Ibid.*

there are a few problems: the Bui Dam currently has a capacity of 400 MW installed; the Aboadze thermal plant has a capacity of 550 MW installed and a maximum capacity of 682 MW; the largest solar plant, the Nzema solar plant, is anticipated to become operational in 2015 and is expected to produce 155 MWh; and there is still a 1049 MW energy capacity shortfall.

4.1.3 Findings in NIGERIA

The Nigerian power sector faces a wide range of issues linked to the implementation of electricity policies, regulatory uncertainties, gas supply, transmission system limitations, and the country's main power sector. The national grid in Nigeria is characterized by an inadequate voltage profile of the network and is confined by a sparse control infrastructure, according to a recent analysis of the country's energy industry (GIZ 2015). High technical and non-technical losses and overloaded transmission lines are frequent occurrences. It is clear that the amount of generated power in Nigeria is insufficient to meet the load demand, primarily because of the country's constantly rising energy needs as a result of its expanding population. This is a call to diversify into additional renewable energy sources to address the inadequacies of power generation. However, there is still a 1049 MW energy capacity shortfall.

The Transmission and Distribution (T&D) sector continues to face a number of challenges despite changes in the power industry, including a 6000MW transmission capacity limit, high technical and non-technical power losses, vandalism and unnecessary power theft, corruption in the power management, an ineffective distribution planning method (no redundancy), an unreliable metering system, inadequate, outdated, and deteriorating T&D infrastructure, poor voltage stability, inadequate coverage, aged and inadequately trained personnel, Radial Transmission Lines with insufficient redundancies to meet up with N-1 contingency criterion. In conclusion, the main issues identified are: It is sponsored completely by the federal government, whose budget allocation is insufficient to meet all the demands; it hasn't yet reached many areas of the country; in comparison to the specified mesh arrangement, certain grid segments have insufficient redundancies; the federal government does not have the necessary funds to continuously improve, modernize, and maintain the network; because all electrical infrastructure is subject to scant monitoring and security, there is routine line vandalism; the technologies employed typically produce very poor voltage profiles and stability; the majority of service regions have overloaded transformers; spare components are not enough for urgent maintenance; and, the distribution system is also confronted with a multitude of problems. Access to the grid presently stands at only 40% of the population. Even the available electricity capacity is insufficient to meet the existing power needs of less than 40% who have access to the national grid. Electricity demand is presently far more than generation and transmission. There are also issues like poor utilization of existing assets and deferred maintenance; delays in the implementation of new projects; lack of sustained, sound, and practicable relationship between the Federal Government and other stakeholders particularly the JV international oil companies and the Independent Power Producers (IPP).

Additionally, there are numerous issues with the distribution method. Only 40% of the population currently has access to the grid. Less than 40% of people who have access to the national grid's current power needs cannot be satisfied by the capacity of electricity that is now available. Currently, demand for power exceeds supply in both generating and transmission: Inadequate use of current assets and neglected maintenance; a delay in the execution of new projects; the federal government and other stakeholders, especially joint venture multinational oil firms and independent power producers (IPP), do not have a long-term, solid, and practical partnership.

4.2 DISCUSSIONS

This study examines factors that support the successful implementation of policies for energy transition and climate adaptation in Ghana, Nigeria, and Cameroon, in particular the northern city of Garoua, Cameroon. The most crucial step is policy implementation, which comes after policy formation. This study's goals are to (i) examine the impacts of climate change on the energy sector (ii) evaluate the implementation strategies of Garoua using the Law and Policy tools, to achieve climate adaptation in the city (iii) identify the gaps and (iii) to pinpoint the gaps and difficulties present in using these tools to the implementation of climate adaption plans while also making further recommendations. These goals are most importantly, to answer the research question, "How effective are laws and governance used in Cameroon, Ghana, and Nigeria to carry out strategies for energy transition and adaptation to climate change?" There are two steps to the methodology. The first is to assess how well policies are being implemented in SSA countries, some tools related to law and policy were broken down into variables. These factors include the tools for developing local policies, engaging relevant stakeholders, addressing climate change, and implementing energy transition initiatives in the cities, particularly in Garoua Cameroon. For the second, seven individuals were reached out to in a qualitative study that involved semi-structured one-on-one interviews. The transcription of each interview got a thematic examination. Following the examination of the two-fold procedure, there were seven key findings which are:

- Inadequate comprehensive adaptation policies anticipating the effects of climate change
- Inadequate infrastructure for the deployment of renewable energy
- The need to increase resilience and strengthen coping mechanisms

- The necessity of bolstering coping skills and resilience across the economy
- A lack of in-depth investigation of the potential of renewable energy
- Several barriers prevent investment in renewable energy
- There are problems with stakeholders' engagement

These issues outline the shortcomings or difficulties encountered in most SSA nations while adopting adaptation and energy transition policies. The difficulties were reviewed, and suggestions for improving the city of Garoua's implementation plans were made.

4.3 RECOMMENDATIONS

i. Improve Collaboration in the Energy Sector, Climate Change Mitigation and Sustainable Development

According to the IPCC, climate change is the greatest security threat of our time. Cameroon must improve global cooperation in the areas of energy, combating climate change, and sustainable development. Yun Gao et al. (2017). According to this analysis, solar energy is the most viable renewable energy source for achieving emission reduction goals in the electrical sector, particularly if the price keeps falling over time. According to Ana Cravinho et al. (2011), the FiT is the best policy instrument for supporting the implementation of renewable energy in Cameroon. Viable investments may be delayed or even cancelled because of inappropriate policies. The government should make its policies known to interested parties and seek to keep its legitimacy. This can also be applied by the governments of the other SSA countries.

ii. Create Comprehensive Adaptation Policies Anticipating the Effects of Climate Change in SSA Countries

Sub-Saharan Africa can increase mitigation and contribute to a green economic recovery from the COVID-19 pandemic by enacting carbon taxes, eliminating energy subsidies, switching to green energy sources, reforestation encouraging carbon capture, and financial regulations limiting investment in polluting capital. However, the region has a larger need for adaptation techniques to increase employment and aid in the economy's ability to recover from the pandemic. Governments can create comprehensive adaptation policies by being aware of the beneficial interactions between adaptation, the macro economy, and development outcomes. Access to financing, land reforms, and strong social protection is important for rural households to protect their assets from climate change. Regional cooperation is essential for adaptation, as international borders are irrelevant to climate change. Technology, expertise, and efficient institutional practices that are actively shared, particularly through regional initiatives, can significantly speed up adaptation.

iii. **Establishment of Institutions and Infrastructure for Renewable Energy Deployment**

Cameroon needs to construct an energy storage system, integrate training programs, and expand them to develop the workforce needed for facility management and maintenance. A service company for RE or other specialized businesses could maintain the sector's efficiency. By supporting qualified equipment installation businesses and operational enterprises, a program for specialized companies seeks to increase the effectiveness of the deployment and the specialities of renewable energy companies. To increase the effectiveness of the deployment and the specialities of renewable energy companies, the Cameroonian renewable energy law needs to be amended to include the requirements for such a corporation. Also, due to the absence of data and statistics, the potential and market for renewable energy in Cameroon are unpopular. The long-term reliability of renewable energy deployment projects may be improved by strengthening information dissemination services, which may also provide a foundation for more engagement from local and foreign private businesses. Additionally, an independent energy research institute is required to improve the management of renewable energy data in Cameroon.

iv. **Develop Broad-Based Adaptability**

It is necessary to increase resilience and strengthen coping mechanisms at the economy-wide level: Strong macroeconomic, institutional, and structural policies are necessary to achieve food security and limit the impact of climate change on economic development and inequality. Having excellent coping skills and resilience could prevent negative outcomes.

v. **Assessment of the Renewable Energy Resource Potential by Region**

Geographically speaking, some parts of Cameroon have greater potential for renewable energy sources than others. Therefore, it is important that the government should make a thorough analysis of the potential for renewable energy and evaluate the resource potential across the country to ensure equitable regional development and create investment plans. Increased stakeholder cooperation is needed for local renewable energy initiatives, and additional funding vehicles should be created for rural illumination, such as the Rural Electrification Fund.

vi. **Create a Strategy for Coping and Resilience**

Strong collaboration between the government (especially between the Ministries of Finance, Agriculture, Education, Environment, and Health, as well as those ministries and agencies responsible for certain forms of infrastructure) and development partners is necessary to implement resilience-building projects, including developing adaptation strategies, evaluating expenditure frameworks, and addressing asymmetries and financial constraints.

vii. Improve the Source of Financing

Cameroon needs to create financial incentives to encourage and remove obstacles to renewable energy investment. The government must remove investment barriers and provide incentive frameworks for the growth of renewable energy. A tender-based FiT is a nationalization of the PPA-based Pre-FiT for large-scale development projects. The government picks applicants in the order of lowest-priced bidders until the predetermined amount is attained after power producers engage in the tender. Cameroon needs a renewable energy agency to manage and oversee the tendering process. The FiT might encourage the deployment of renewable energy and the demand for renewable energy in Cameroon and help develop renewable energy in underdeveloped rural and off-grid areas.

In a nutshell, I admit that there was insufficient data for my analysis, which is a shortcoming. To further assess this topic, I would like to research more data sources in this regard.

CONCLUSION

Global issues like climate change pose significant sociopolitical and economic difficulties. All should be interested in efforts to combat them, notably state actors, and polluters. This is required since the effects of climate change cut across national borders and differ from region to region. In order to support the Paris Agreement, it is vital and proactive for Cameroon to develop a functional climate change regime (Oluwole, 2016). Given that Cameroon lacks a policy on renewable energy and the pressing need to meet the NDC's targets regarding the Paris Agreement and the global agenda toward SDGs by 2030, this paper represents an effort to suggest policies for the deployment of renewable energy in Cameroon (Muhammad et al., 2019). The IPCC has identified climate change as the biggest security risk of our time. Cameroon must improve global cooperation in the areas of energy, combating climate change, and sustainable development. (2017) Yun Gao et al. According to this analysis, solar energy is the most viable renewable energy source for achieving emission reduction goals in the electrical sector, particularly if the price keeps falling over time. It also demonstrates that the FiT is the best policy instrument for supporting the implementation of renewable energy in Cameroon (Ana Cravinho et al., 2011). Viable investments may be delayed or cancelled due to inappropriate policies. The government should make its policies known to interested parties and seek to keep its legitimacy.

Energy systems are complex and involve many end-use industries, fuel sources, extraction and conversion techniques, financiers, workers in the infrastructure, and trade unions. It is primarily for this reason that some foreign donor organizations can support a range of energy projects. To make the transition to a more sustainable energy future, it is necessary to consider market dynamics, legal requirements, public acceptability, and the support of various stakeholder groups to make the transition to a more sustainable energy future.[165] Sound policies could aid in lowering uncertainties caused by changes in market rules, such as legislative, climatic, or technological ambiguities. In the Nigerian context, it is advised that the government increase stakeholder involvement through various public engagement forums to give different interest groups a chance to provide the necessary inputs before a final decision is made on electricity infrastructure provisions.

The previous chapters provided an overview of the legal and policy framework for implementing policies for energy transition and climate adaptation in SSA countries. Research has found that laws and regulations are essential to the energy transition and the adaptation to climate change. However, the execution of laws and regulations pertaining to climate change and the transition to clean energy can be particularly challenging in nations like Cameroon, Ghana, and Nigeria. This could be interpreted as evidence that the governance structure is deteriorating. The energy sectors of many African cities suffer from poor horizontal and vertical coordination, mistrust of stakeholder involvement, ambiguous policies, and restricted access to financial resources. These problems might be resolved by enhancing public participation and consultation forums, providing clear policies and execution strategies, completing budgetary plans, etc. This study has looked at the laws, regulations, and policies governing energy transition and climate change adaptation in the Northern city of Garoua, Cameroon, but many of the problems it identifies are widespread throughout other African nations.

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ANNEX A (INTERVIEW QUESTIONS)

A STAKEHOLDER FROM A FINANCIAL INSTITUTION

QUESTIONS DIRECTED TO UNIVERSITY PROFESSORS AND RESEARCH INSTITUTIONS

1. What do you believe are the roles of academics, universities, and research institutions in achieving climate-resilient cities and sectors, considering your scholarly and research contributions to the topics of environment, human rights, climate change law and policy, and sustainable development goals? Practically speaking, do you believe this field has contributed enough so far?
2. It is often said that most of the government legislation and regulations related to the environment and the climate only exist on paper. Do you believe that the law has been sufficient to combat the effects of climate change? In your opinion, has there been a global strategy for environmental conservation?
3. Do you believe that achieving climate resiliency has been significantly hampered by a lack of competent expertise or poor knowledge transfer?
4. Do you believe that the law—much like the national and municipal laws in Nigeria—has been sufficient to combat the effects of climate change?
5. How often do you engage in communication with the government and other public actors to participate (co-design meetings, participatory processes)? In order words, how do you find engagement with them?
6. How do your scientific contributions serve as a practical weapon in the fight against environmental and climate change?

QUESTIONS DIRECTED TO PRIVATE ACTORS FROM THE ENERGY SECTOR AND ANY CONSULTANT FIRM WITH THE GOVERNMENT, AND TO ANY CITY OFFICIAL AT THE LOCAL GOVERNMENT LEVEL

1. Could you provide further information on any current energy transition projects you know of and have worked on, particularly in Cameroon and in Africa in general?
2. What is the time horizon for your most recent projects, and how long-term sustainable are they?
3. What kind of inclusive and collaborative approach with other stakeholders does your project envision? Do any additional important players exist, such as universities and research? Do these projects always require and obtain government backing and approval?
4. What practical steps have you taken in the energy transition to ensure that you are assisting the transition to climate-resilient cities?

5. Do you create, carry out, or market your work using any internet software? If so, do you think technology had a significant impact on the initiatives' promotion of community development and participatory governance? How do these initiatives handle concerns about data ownership and privacy?
6. What part does the government play in your project(s), based on your prior experience? Can you name any specific government assistance you received for a project? Do you find it difficult to engage the government in conversation in order to participate (co-design meetings, participatory techniques)?
7. To what extent does your city's public priorities-setting process incorporate participation or group decision-making? Do you frequently communicate with other participants in the construction of energy transition initiatives in your city?
8. How does this city's local government support projects involving the transition to renewable energy? Do you believe that technology has enhanced community engagement and development in these projects?
9. How will some of these energy-related projects help other cities?
10. What difficulties do local officials frequently face when taking part in energy transition programs in this city?
11. What do you see as the energy sector's future in your city, and what will it look like in 20 years?

QUESTIONS DIRECTED TO GHANAIAN CITIZENS

1. Do you have any knowledge of renewable energy initiatives in your city in Ghana?
2. Would you say that the government is doing a good job of ensuring that the people have good access to electricity?
3. Does the local administration frequently host seminars, conferences, or regional get-togethers to collaborate with residents on city projects? Do you think the public is sufficiently involved in these projects' decision-making processes?
4. Do you think technology, such as the use of social media, may help to foster greater public participation in these initiatives?
5. Why, in your opinion, do you think there are so few sustainable energy efforts in your city?
6. What practical steps have you taken in the energy transition to ensure that they are assisting the transition to climate change?

ANNEX B (INFORMED CONSENT FORM)

This is a research project that is dedicated to developing a theoretical and analytical framework based on a large dataset of secondary and primary data. The results of these research efforts will be collected and analyzed accordingly. The findings in this research reflect collection efforts by a researcher who found information online, in scientific literature, or through first-hand interviews with representatives involved in the project. Additionally, the material could be later included in scientific articles, doctoral dissertations, and master theses by Luiss University, students, or the public. The answers of the interviewer will not be published entirely. The research outcomes will be made available in both digital format and books/articles. The research outcomes will be made available, when possible, in open access format.

1. I, …………., hereby certify that I accept to participate in this interview

2. I (tick the one that applies)

a. prefers to be known as ‘anonymous.

c. prefers to that my name is termed as ‘anonymous’ and my position described as ……………………………………………………………………… (description of position).

3. I understand that the researcher might necessarily use data anonymously for privacy regulation.

4. I am conversant with the aims and nature of the research project and having been told of my contribution. I was sent a copy of this consent form, with a summary of the research aims.

5. I understand that the content of the interview is subject to the analysis of the researcher analysis and interpretations.

6. I agree that some parts of them are made public through quotations in the files that will be put online.

7. I acknowledge that I gave my approval to the file based on one interview before they were made public in the open-access database. I was made aware of the content of such a file.

8. I accept that the data might be further processed for scientific purposes, in line with the Italian law on privacy (https://www.garanteprivacy.it/home_en/italianlegislation
on the protection of privacy regarding the processing of personal data. Users of database contents are requested to refer to the database.

9. I accept that the results of the research will be used for scientific purposes, in compliance with the ethical standards of the scientific community.

Location: ………………………………………………………………

Date: ……………………………………   Signature:

SUMMARY OF THE THESIS

Summary of Chapter 1 - Introduction

Chapter 1 of the document introduces the study, including the research question, research method, and aims of the study. The chapter aims to provide a background and context for the research that follows. It then discusses the research method, which involves the use of both secondary and primary data. The primary data was collected through interviews in the City of Garoua, Cameroon.

The chapter also outlines the aims of the study, which is to investigate the impact of climate change on the energy sector in SSA countries particularly the city of Garoua in Cameroon and assess the effectiveness of the city's implementation plans for climate adaptation in the context of legal and policy frameworks. The study aims to identify the limitations and challenges in using tools such as institutional frameworks, local policy development, stakeholder engagement, climate litigation, and energy transition projects to implement climate adaptation strategies. The study also seeks to provide recommendations for establishing legislation and regulations that will enable the use of clean, safe, cost-effective, and efficient renewable energy sources in Garoua. The research aims to contribute to the scientific framework for assessing the effectiveness of current implementation plans and provide sound recommendations for decision-makers and stakeholders on improved ways to implement Garoua's climate adaptation strategy.

The chapter does not explicitly state a hypothesis, but based on the aims of the research, a possible hypothesis could be:

- If legislation and regulations are established to enable the use of renewable energy sources in Sub-Saharan African countries, and if the limitations and challenges in implementing climate adaptation strategies in the energy sector are identified and addressed, then the countries and particularly the cities will be better equipped to mitigate the impact of climate change on the energy sector and achieve successful results for climate adaptation.
- Additionally, in the case of Cameroon, if the effectiveness of Garoua's implementation plans for climate adaptation is assessed in the context of legal and policy frameworks, and if recommendations are provided for improved ways to implement the city's climate adaptation strategy, then decision-makers and stakeholders will have a scientific framework for assessing the effectiveness of current implementation plans and a direction for future policy development.

Overall, Chapter 1 provides an overview of the research question, method, and aims of the study. It sets the stage for the empirical investigation that is carried out in subsequent chapters.

Summary of Chapter 2 – Literature Review

Chapter 2 is the literature review that discusses energy communities, energy transitions in Sub-Saharan Africa, and the effects of climate change on the energy sector in Cameroon. The chapter aims to provide a deeper understanding of the subject matter and identify areas where further research is needed.

The chapter begins by discussing the concept of energy communities and their potential to contribute to the energy transition in Sub-Saharan Africa. It then examines the current state of energy transitions in the region, highlighting the challenges and opportunities for renewable energy development.

The chapter also explores the effects of climate change on the energy sector in Cameroon, including the impact on energy supply and demand (energy security, access, and affordability), as well as the potential for renewable energy development. It identifies gaps in the literature, such as the lack of research on the role of local governance in promoting renewable energy, the lack of research on the role of institutional frameworks, local policy development, stakeholder engagement, climate litigation, and energy transition projects in implementing climate adaptation strategies, and discusses how the research relates to these gaps.

Overall, Chapter 2 provides a comprehensive overview of the literature on energy communities, energy transitions, and climate change in Cameroon and Sub-Saharan Africa. It sets the stage for the empirical investigation that is carried out in subsequent chapters.

Summary of Chapter 3 - Methodology

Chapter 3 is mainly on the research methodology and focuses on the law and policy on renewable energy in Cameroon, Ghana, and Nigeria, as well as the challenges and opportunities of climate change litigation in the countries. The chapter highlights the energy sector in Garoua, Cameroon, which has launched a Sustainable Energy Access and Climate Action Plan (SEACAP) to reduce emissions and increase household access to electricity through the production of renewable energy.

The chapter explores various renewable energy projects, including hydroelectricity, solar projects, and mini-grids, and identifies stakeholders for effective renewable energy implementation. The stakeholders identified for effective renewable energy were the local management committees, microfinance organizations, non-governmental organizations (NGOs), renewable energy enterprises (REEs), and universities. Below are the Tools used to analyze the Local Level Readiness assessment in the energy sector:

Tool #1, which is **Local Policy Development,** mentions the SEACAP (Sustainable Energy Access and Climate Action Plan) as an important document for understanding the current state of energy and climate action in Garoua and for developing policies and strategies to address the challenges identified. The SEACAP was developed by the city of Garoua with the support of the Covenant of Mayors in Sub-Saharan Africa (CoM SSA) initiative. The SEACAP contains the results of 9 technical reports using literature reviews, surveys, interactive workshops, and participatory mapping exercises. It focuses on transforming key sectors such as transport, waste, agriculture, and livestock, and provides a roadmap for ensuring affordable and sustainable energy for citizens while preserving the environment. The CoM SSA initiative will continue to support Garoua in maturing projects to a more bankable stage, by helping local governments identify financing mechanisms and investors.

Tool #2 – Institutional Framework in Place: Cameroon has ratified numerous international conventions, such as the UNFCCC, Kyoto Protocol, UNCBD, and UNCCD, which have been transformed into national implementation plans. The National Climate Change Adaptation Plan (PNACC) and the National Biodiversity Strategy and Action Plan (NBSAP II) aim to help Cameroonians adapt to climate change by lowering their susceptibility to its effects, raising their level of resilience and quality of life, and enhancing their capacity for adaptive growth to open new opportunities for the nation's sustainable development. In order to achieve this, the Plan has the following four strategic goals: (i) increase awareness of climate change in Cameroon; (ii) inform, educate, and inspire the population to adapt to climate change; (iii) lessen vulnerability to climate change in the nation's major sectors and agro-ecological zones; and (iv) incorporate adaptation to climate change into strategies and national sectoral policies. The Cameroon Vision 2035 is a project that aims to transform the nation into a Newly Industrialized Country (NIC).

Tool #3 – Stakeholder Engagement: In Cameroon, the stakeholders identified for effective renewable energy were the local management committees, microfinance organizations, non-governmental organizations (NGOs), renewable energy enterprises (REEs), and universities.

First, the administration, operation, and upkeep of installed systems, as well as the revenue collection based on fee-for-service tariffs, must be handled by local management committees. In accordance with predetermined monthly energy expenditures, microfinance organizations should grant loans to communities for the purchase of commercially and economically viable off-grid renewable energy systems. Also, NGOs are expected to offer technical support in the development of community projects, in obtaining money from cooperation partners, and in seeing that projects are carried out. Equipment for generating green energy should be sized, installed, and maintained afterwards by REEs. Universities are responsible for training the techs and engineers that NGOs and REEs will employ.

The first Department of Renewable Energy at the University of Maroua was established in 2008 in recognition of this important function by the government of Cameroon.

In his article, C. Iaione explores whether urban resources and assets may be turned into ecosystems that encourage cooperation, sharing, and commoning, and permit collective actions for the commons. To him, this can be achieved by switching from closed, centralized institutions to co-owned, co-managed, and co-produced institutions for the governance of urban resources as commons so that the community can reap the benefits. His analytical framework is based on a few key components that are still missing from urban governance schemes: organizational innovations within city administrative structures, a communication strategy using a democratic digital platform as the primary tool, and bridging institutions that spread commoning culture and practice at the city level and in neighbourhoods. C. Iaione also recommends that cognitive institutions like schools, universities, and policymakers need to have their roles rethought and function as facilitators rather than authorities or producers of specialist knowledge.[166]

Tool #4 – Implementation Challenges of Climate Change: This work analyzed transnational litigation and climate change in Nigeria, which has become increasingly important in supporting regional and domestic initiatives for climate action. Non-state actors, particularly multinational corporations, are crucial to the international framework for addressing climate change, and victims and their advocates have turned to climate litigation as a key tactic to control how businesses affect human rights and the environment. In Urgenda Foundation v. State of the Netherlands, the Dutch Supreme Court ordered the government to reduce greenhouse gas pollution by 25% below 1990 levels by 2020. This has never happened before in any country or region. The appropriate stakeholders use transnational climate change litigation to make African nations and MNCs answerable for the impacts of climate change and associated human rights violations. In Milieudefensie et al. v. Shell, the District Court of The Hague ordered Royal Dutch Shell to cut down CO2 emissions by 45% by 2030. Citing the UN Human Rights Committee and the UN Special Rapporteur on Human Rights, the court emphasized the value of a human rights strategy in cases involving climate change. Civil Society Organizations (CSOs) in Nigeria have turned to litigation to sway the actions of the government and multi-national companies (MNCs) in the oil and gas industry.

These cases demonstrate the methods local communities use to pursue judicial enforcement of their contracts with MNCs outside of Nigeria as well as the potential judicial remedies open to host communities that experience environmental injustice.

[166] See footnote 143 supra.

Tool #5: Energy Transition Projects

This part discusses energy transition projects in Cameroon, Ghana, and Nigeria. These projects aim to promote sustainable energy and increase access to electricity in areas where the electrical grid is not present. The projects include the development, construction, and operation of renewable energy-generating facilities outside the electrical grid, such as solar, biogas, hydroelectric, and mini-grids. The projects are often implemented by government agencies, private companies, or in partnership with foreign donor organizations. The projects aim to provide clean, reliable, and inexpensive electricity to homes and businesses outside the distribution network, promote economic expansion, and mitigate climate change.

A) Energy Projects in Cameron:

i) The Nachtigal Hydropower Plant

Nachtigal is a key project in Cameroon, with an installed capacity of 420 MW and an estimated cost of 1.2 billion euros. It is 30% of Cameroon's electricity production.

Figure 12a:[167] Dam under construction: Channel intake, spillways, and temporary diversion – April 2022

Figure 12b: Hedrace channel under construction: Headrace channel: laying the bituminous lining – April 2022

Figure 12c: Energy production plant under construction: Plant (7x60 MW Units) – April 2022

[167] Sources of Figures 12a, b, c, d: EDF Cameroon

Figure 12d: 225kv transmission line completed: Evacuation station (foreground) – Evacuation lines to Nyom 2 station (background) April 2022

EDF supports Société Générale in its energy efficiency initiatives

EDF signs a contract with Société Générale Cameroun to install a customised solar solution to power the country's main bank branches. This initiative will reduce carbon emissions by around 2,000 tonnes, which corresponds to "almost 12,000 trees planted in Cameroon". This initiative by Société Générale Cameroun also contributes to the diversification of the country's energy mix, which is still largely dominated by hydroelectricity and thermal energy. Solar, biomass, and wind power still represent barely 1 % of the energy mix.

ii) **Kikot Hydroelectric Scheme:** EDF and the Government of Cameroon have signed a development agreement for the Kikot project, which includes a dam and hydroelectric plant with a capacity of 450-550 MW. A dedicated team is engaged in the project and environmental, societal, and technical studies are underway to design a sustainable and efficient project that respects the environment and people.

Figure 13: Kikot Hydroelectric Scheme[168]

The Memorandum of Understanding was signed on November 26, 2019. On June 25, 2021, the development agreement with the Government of Cameroon was held. 2022 – 2024 Environmental and technical research; business setup and closing. The construction is expected to begin in 2025. The power plant will be put into service in 2029. The power system is not linked to 45% of the population.

[168] *Ibid.*

In Cameroon, 2.3 million households lack access to electricity. 15 years of off-grid experience. 1 million consumers who are off the grid by 2030.

iii) **Cameroon Rural Solar Project**: Huawei Technologies Co. Ltd. carried out a rural solar project in Cameroon in two stages to supply power to rural communities. However, the Far North Region was excluded from the first phase due to security concerns brought on by the resurgence of Boko Haram. The implementation of this initiative in the English-speaking North West and South West Regions have been considerably impacted since 2016 by the political instability in these two regions. Due to security concerns, work on the second phase of the project was put on hold and a "Prime Ministerial decision" was issued to make provisions for the relocation to the eight French-speaking districts.

iv) **Independent Solar Kits**: 2020 saw the launch of 300 solar systems made by the German company Solarworx thanks to a partnership between EDF and upOwa and Solkamtech, two Cameroonian businesses that specialize in the distribution of standalone solar kits. Promoting sustainable energy to homes and businesses outside the distribution network is the goal of this experimental initiative.

v) **Mini-Grids:** Mini-grids are technical ways to increase people's access to energy in areas where the electrical grid is not present. In Cameroon today, around 45% of the population lacks access to electricity. Supporting the government and local authorities in their electrification efforts is one of EDF's goals. EDF intends to develop, construct, and run a variety of renewable energy-generating facilities outside the electrical grid (solar, biogas, hydroelectric). Below are the RE Technologies in Cameroon:[169]

a) **Hydropower:** Cameroon ranks third in Sub-Saharan Africa in terms of hydropower potential, behind the Democratic Republic of the Congo and Ethiopia. The government is planning to build 2500 MW of capacity between 2012 and 2020, including 298 MW of thermal capacity, to meet rising demand. Other dams are being built such as Lom Pangar (170 MW), Natchigal (280 MW), Song Dong (280 MW), and Menve'elé (200 MW).

b) **Biomass:** Cameroon has the third-largest biomass potential in Sub-Saharan Africa, with agriculture and forestry accounting for a major portion of its potential. However, the widespread use of biomass energy has led to extensive deforestation, contributing to global warming.

c) **Solar Energy:** With the highest values in the far north, the daily solar radiation averages between 4.5kWh/m2/day in the south and 5.7kWh/m2/day in the north. Germany, which only uses 1.7 kWh/m2/day on average, has more than 40 000MW of solar energy installed. In other words,

[169] https://centurionlg.com/2022/02/07/renewable-energy-plans-in-cameroon-2/

Cameroon has considerable solar potential. There are currently plans to take advantage of solar energy, which has not been fully used.

d) **Wind Energy:** Cameroon has an inadequate potential for wind. The Mount Bamboutos region of Cameroon has the capacity to generate about 400MW using proven resources. More importantly, Cameroon has a great deal of potential for creating off-grid solutions that can help with electrification using cheap and clean energy sources in a short amount of time. Despite the government's efforts to utilize these places, this area is likewise not thoroughly explored.

B) Ghana Renewable Energy Projects: Navrongo Solar PV Project

The Navrongo solar PV project was completed in 2013 and feeds 3.8 GWh annually into Ghana's national power grid, which is run by Ghana Grid Company (GRIDCo) and off taken by Northern Electricity Distribution Company (NEDCo). It was part of VRA's 2010-created Renewable Energy Development Programme (REDP) and includes 150 MWp of wind energy near the VRA Akosombo plant and 14.5 MWp of PV at three to four sites in Ghana's northern region. VRA has hired Lahmeyer International, a German engineering firm, as the owner's engineer for the REDP in general and Navrongo in particular.

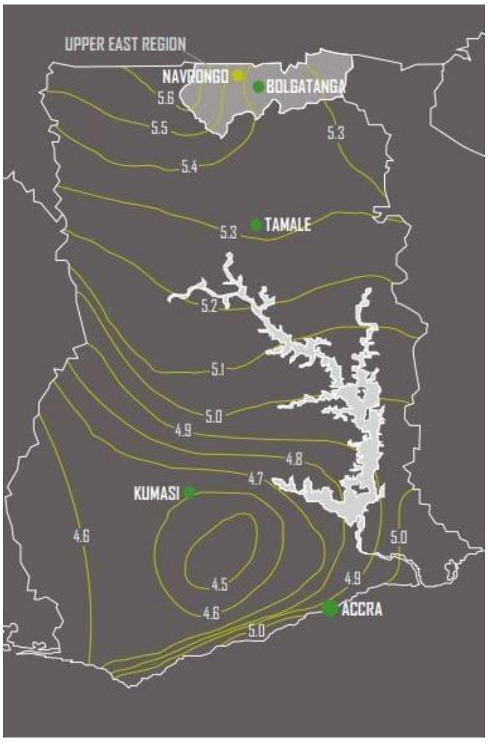

Figure 14: Solar Radiation Map of Ghana (kWh/m²/day) adopted from ECREEE case study Navrongo Solar PV Project Ghana

VRA completed the procurement procedure in Ghana and Lahmeyer International carried out an environmental analysis. In late 2012, the project was approved as part of a multi-country Programme of Activities (PoA) created by the UK-based Standard Bank. However, one of the earliest CDM projects in Ghana was abandoned due to the decline in CER prices. The Navrongo plant has been running since February 2012 and produces 3,800 MWh of energy annually. The primary economic benefit of PV injection in Ghana is the savings of thermal fuel.

Additional advantages such as jobs, a decrease in energy prices, and avoided carbon emissions are smaller. Navrongo was the first utility-scale PV plant in Ghana, and the energy pumped by the plant is valued between 0.15 and 0.35 USD/kWh. The project's primary environmental advantage is the impact on the global climate from replacing thermal fuel with PV energy. The Bui Power Authority (Amendment) Act 2020 granted the Authority the legal authority to carry out clean energy alternatives, carry out its own renewable energy operations, and carry out projects involving renewable energy on behalf of the State. The benefits of the projects include support for the government's initiative to boost renewable energy's share of the energy mix by 10% by 2030, the creation of jobs for Ghanaian workers, the establishment of a hydro-solar PV hybrid system to aid in the preservation of the Bui reservoir, providing clean energy, and increasing the number of families with access to electricity.

C) Nigeria Energy Projects

i) Hydro Project: Mambilla Hydropower Project

The Mambilla Hydropower Project is being built on the Dongo River in Kakara Village, Taraba State, Nigeria, with the aid of Chinese investments. It will be Nigeria's largest power plant and produce 4.7 billion kWh of electricity annually, creating up to 50,000 local jobs. The project consists of two subterranean powerhouses, four underground dams, and 12 turbine generation units. Four 500kV DC transmission lines linking Makrudi and one 330kV DC transmission line connecting Jalingo will carry the output to the national grid.

ii) Renewables: 1mw Interconnected Mini-Grid

The Abuja Electricity Distribution Company (AEDC), Green Village Electricity (GVE), and the Wuse Market Association have signed a tripartite agreement for the construction of a 1 MW interconnected mini grid at the Wuse market in sub-Saharan Africa. This project is part of the Energizing Economies Initiative and aims to provide SMEs with clean, reliable, and inexpensive electricity. It will use 3 independent hybrid PV solar systems with a combined capacity of 450kWp, 350kWp, and 200kWp to service 3 different market segments in the Wuse region. Over 2,000 Small and Medium Scale Enterprises will be provided with uninterrupted power because of the project, which will also promote economic expansion.

iii) Nuclear Energy

The Federal Government of Nigeria (FGN) established the Atomic Energy Commission (NAEC) as the focal promotional institution to provide the technical leadership to achieve this national goal in recognition of the need to enhance the nation's national electricity supply and investigate the potential of nuclear energy. The NAEC created a technical framework and approved a Strategic Plan for the Implementation of the National Nuclear Power Program in Nigeria in 2009, which will lead to the commercial operation of the first NPP by 2025.

iv) Rural Electrification Projects

The Nigeria Rural Electrification Agency (REA) is responsible for providing rural residents with steady electricity access through the Renewable Electrification Fund (REF). However, only 26% of rural households have access to power, and the Federal Government of Nigeria (FGN) has pledged to invest NGN 317.8 billion and NGN 525.8 billion annually to achieve 75% and 100% electricity access by 2020 and 2040, respectively. The REMU serves as a Sustainable Platform for Integrated Economic

Empowerment (SPIE), and the Nigeria Electrification Programme supports the Power Sector Recovery Plan (2017–2021) goals to enhance private investment in the energy industry. Some of the programs currently being implemented are Solar hybrid mini-grids, the Minimum Subsidy Tender for Solar Hybrid Mini-Grid, Standalone Solar Home Systems for Households and MSMESs, and the Energizing Education Programme II & III. Chapter 3 provides an overview of the law and policy on renewable energy in Cameroon, Ghana, and Nigeria, and highlights the challenges and opportunities of climate change litigation in Nigeria.

Summary of Chapter 4 – Research Findings and Discussions

Chapter 4 presents the research findings and discussions on the legal and policy framework for implementing policies for energy transition and climate adaptation in Sub-Saharan African (SSA) countries, with a focus on Cameroon. The chapter highlights the importance of laws and regulations in the energy transition and adaptation to climate change but also notes the challenges in executing these laws and regulations in countries like Cameroon, Ghana, and Nigeria.

The chapter discusses the barriers to renewable energy (RE) development in Cameroon, including insufficient infrastructure, overreliance on hydro and gas, poor access to electricity, expensive fuel, transmission and distribution losses, insufficient regulatory capacity, and vulnerability to climate change. The chapter also highlights the role of stakeholders, such as local management committees, microfinance organizations, NGOs, REEs, and universities, and ineffective RE implementation. Below are the findings in each country:

4.1.1 Findings in CAMEROON

i) **Barriers to RE development:** Renewable energy is the primary energy source in Cameroon, but its success is limited by policy and legal, technical, and financial issues. These include a lack of regulatory and legislative framework, a lack of RE Technology expertise, labour scarcity, and a lack of low-cost financing options.

ii) **The Absence of Cogent Strategic Aims, and the Sector's Financial Stability**: The electricity sector in Cameroon is experiencing difficulties due to SONATREL's operationalization, lack of strategic aims, and financial instability. A new strategy is needed to coordinate and direct future investment.

iii) **Climate Change:** Due to climate change, recent drought occurrences have highlighted the need for better planning and management of hydroelectric plants. The Lagdo dam's output has been damaged by drought, leading to an emergency plan to supply electricity to the North, raising energy and CO2 emissions. Access policies must focus on rehabilitating and expanding distribution networks.

iv) The Lack of Availability in Rural and Low-income Areas: Due to the lack of availability in rural and low-income areas, Cameroon, an SSA country, is experiencing financial difficulties. As ENEO will not be able to pay or obtain financing for unprofitable access programs, it must concentrate on safer and higher-income areas to reduce negative effects and the possibility of a lack of subsidies. By reorganizing its debt and advancing its ten-year investment plan, ENEO must address its liquidity issues to maintain its financial survival. The GoC and state-owned businesses are heavily in debt, which puts financial strain on ENEO.

4.1.2 Findings in GHANA

i) The Potential of Solar Energy in Ghana: Ghana has a high potential for solar energy generation, but obstacles such as lack of political will, technical know-how, components, funding, and land have slowed its expansion. Gyamfi et al.'s study showed that 90% of all renewable energy installations in Ghana are solar energy installations. Energy policy, technological viability, equipment supply, manufacture, and finance of solar energy use are barriers to its use.

ii) Challenges: Most stakeholders who participated in the interview in this research manifested their grievances regarding the power sector in Ghana which is faced with a few difficulties, such as insufficient infrastructure for power supply that requires significant investment, an overreliance on hydro and gas, poor access to electricity, expensive fuel used to generate electricity, transmission and distribution losses, insufficient regulatory capacity, enforcement issues, operational and management issues, and vulnerability to climate change. The quest for cleaner energy and the growing living standards of Ghanaian citizens provides significant obstacles to future power development.

iii) Limited Generation Capacity of Power Plants: Ghana's power supply difficulties are caused by unpredictable patterns of rainfall and inflows into hydropower plants. The country is forced to rely on oil and gas-fueled thermal power plants due to restricted water inflows, which cannot operate at full capacity, as well as due to the scarce and expensive fuel supply.[170] With outdated infrastructure and a precarious financial situation, VRA, the Electricity Company of Ghana (ECG), and Ghana Grid Company Ltd. (GRIDCo) are all contributing to blackouts. The Tema Oil Refinery's processing capacity has remained unchanged, making it unable to import and process enough crude oil to meet demand.[171]

[170] This information was expressed by most stakeholders, and participants in the interview, particularly the local citizens, a PhD researcher in Economics, as well as most private actors in the energy sector in Ghana.
[171] Ghana Wholesale Power Reliability Assessment (2010) Final report. Power Systems Energy Consulting, GRIDCo.

iv) **High Cost:** Most energy firms in Ghana are state monopolies, responsible for energy production, transmission, and distribution, but they are facing high costs due to lack of funding and investment, shoddy infrastructure, inadequate performance, and poor administration.[172] Frequent power outages are caused by overloaded transformer sub-stations, transmission and distribution losses, and transmission bottlenecks. Current hydroelectric plants have maintenance and capital expenditures, which are financed by the sales of energy.[173] To meet demand, it is necessary to build additional plants, which will increase costs and lower system returns. The high cost of technology to generate renewable energy sources is another cost factor.

v) **Sustainability:** The Ghanaian power sector needs competitively priced energy to be financially viable, and the government spent $900 million on fuel subsidies to VRA in 2004. However, due to their failure to maintain and build the necessary infrastructure, the transmission and distribution agencies (VRA and ECG) are in a financial situation. To keep the cost of supply as low as possible while preserving the sector's financial viability, the operational and production effectiveness of the sector's authorities is essential.

vi) **Growth and Development Implications:** Low rates of electrification in Ghana are having a negative impact on economic growth and development, as it is necessary for technology to be used and infrastructure to support development. Without electricity, the infrastructure that supports development will crumble, and businesses and sectors choose to insure themselves against outages by investing in expensive generators and plants. Unreliable power supplies and outages have financial costs.

vii) **Energy Sector Initiatives and Power Sector Reforms:** The World Bank and the International Development Association (IDA) have played a significant role in power sector reforms over the past four decades. The IDA has helped Ghana improve its distribution networks, finance the Akosombo Dam and the Kpong Power Plant, repair transmission systems, extend the grid to the northern regions, and provide electricity to small urban areas, district capitals, and rural areas. The 2008-established Electricity Regulation was created to develop a competitive wholesale electricity market and support Ghana's efforts to reach a 5000 MW electricity generation capacity by that year.

As per research, the power sector in Ghana has benefited from donor funding since 1960, with the Structural Adjustment Program of 1986 and the Electricity Regulation being established in 2008.

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[172] Energy Sector Strategy and Development Plan (2010) Ministry of Energy. Ghana.
[173] *Ibid.*

The National Energy Policy (2010) is being implemented to promote the successful management and growth of the sector. However, there are still a few problems, such as the Bui Dam currently having 400 MW installed, the Aboadze thermal plant having 550 MW installed, and the Nzema solar plant having 155 MWh. There is still a 1049 MW energy capacity shortfall.

4.1.3 Findings in NIGERIA

The Nigerian power sector is facing a range of issues, including an inadequate voltage profile, high technical and non-technical losses, overloaded transmission lines, and a 1049 MW energy capacity shortfall. The Transmission and Distribution (T&D) sector also faces challenges such as a 6000MW transmission capacity limit, high technical and non-technical power losses, vandalism, corruption, an ineffective distribution planning method, an unreliable metering system, inadequate infrastructure, poor voltage stability, inadequate coverage, aged personnel, and Radial Transmission Lines with insufficient redundancies. The main issues with the national grid are that it is sponsored by the federal government, whose budget allocation is insufficient to meet all the demands, it hasn't yet reached many areas of the country, certain grid segments have insufficient redundancies, the federal government does not have the necessary funds to continuously improve, modernize, and maintain the network, there is routine line vandalism, the technologies employed typically produce poor voltage profiles and stability, the majority of service regions have overloaded transformers, spare components are not enough for urgent maintenance, and the distribution system is confronted with a multitude of problems.

Finally, the chapter discusses the readiness of Garoua, Cameroon, for the shift to a clean energy society, emphasizing positive trends and areas for development. The chapter evaluates the city's readiness based on local policy development, institutional framework, stakeholder engagement, climate change litigation, and energy transition projects. The chapter notes that the city's SEACAP is being developed in alignment with priority sectors, targets, and actions that will increase the city's resilience to climate change by 2035.

DISCUSSIONS

This study examines factors that support the successful implementation of policies for energy transition and climate adaptation in Ghana, Nigeria, and Cameroon, in particular the northern city of Garoua, Cameroon. The study's goals are to examine the impacts of climate change on the energy sector, evaluate the implementation strategies of Garoua using the Law and Policy tools, identify the gaps and difficulties present in using these tools to the implementation of climate adaptation plans, and make further recommendations. Seven key findings were identified, including inadequate comprehensive adaptation policies, inadequate infrastructure for the deployment of renewable energy, the need to increase resilience and strengthen coping mechanisms, the lack of in-depth investigation of the potential of renewable energy, several barriers preventing investment in renewable energy, and problems with stakeholders' engagement. These issues outline most SSA nations' shortcomings or difficulties while adopting adaptation and energy transition policies. The difficulties were reviewed, and suggestions were made for improving the city of Garoua's implementation plans.

CONCLUSION

Global issues like climate change pose sociopolitical and economic difficulties, and Cameroon, for instance, must improve global cooperation in energy, combating climate change, and sustainable development to meet the NDC's targets regarding the Paris Agreement and the global agenda toward SDGs by 2030 (Oluwole, 2016). Yun Gao et al. have identified solar energy as the most viable renewable energy source for achieving emission reduction goals in the electrical sector, and the FiT is the best policy instrument for supporting the implementation of renewable energy in Cameroon. The government should make its policies known to interested parties and seek to keep its legitimacy. The government should make its policies known to interested parties and seek to keep its legitimacy. Foreign donor organizations are able to support energy projects. To make the transition to a more sustainable energy future, it is necessary to consider market dynamics, legal requirements, public acceptability, and the support of various stakeholder groups.

In Nigeria, it is advised to increase stakeholder involvement through public engagement forums. Research has found that laws and regulations are essential to the energy transition and the adaptation to climate change, but the execution of laws and regulations pertaining to climate change and the transition to clean energy can be particularly challenging in nations like Cameroon, Ghana, and Nigeria. Energy systems are complex and involve many end-use industries, fuel sources, extraction and conversion techniques, financiers, workers in the infrastructure, and trade unions.

This study looked at the laws, regulations, and policies governing energy transition and climate change adaptation in Garoua, Cameroon, but many of the problems it identifies are widespread throughout other African nations.

RECOMMENDATIONS

i. Improve Collaboration in the Sectors of Energy, Climate Change Mitigation and Sustainable Development

ii. Create Comprehensive Adaptation Policies Anticipating the Effects of Climate Change in SSA Countries

iii. Establishment of Institutions and Infrastructure for Renewable Energy Deployment

iv. Develop Broad-Based Adaptability

v. Assessment of the Renewable Energy Resource Potential by Region

vi. Create a Strategy for Coping and Resilience

vii. Improve the Source of Financing