EISSN: 2707-0425

*East African Journal of Science, Technology and Innovation, Vol. 2 (Special issue): May 2021*

This article is licensed under a Creative Commons license, Attribution 4.0 International (CC BY NC SA 4.0)

# Evaluation of policies as drivers of energy transition and modeling of a low carbon emission scenario for the energy generation sector in Kenya

[1*]NGUNGI J M., [2]NZIOKA. J M

[1]Department of Energy Sciences, Pan African University Institute of Water and Energy Sciences including climate change (PAUWES), Tlemcen, Algeria
[2]Wangari Maathai Institute for Peace and Environment, University of Nairobi

[*]**Corresponding Author**: judyngungi@gmail.com

**Abstract**

Energy transition is considered integral in seeing countries reduce their emissions and thus reduce the effects of global warming. Understanding the energy, food, and climate change nexus is important for the achievement of a green economy. This paper examines how energy transition plays a key role in the shift to a low-carbon economy and address greenhouse emissions in the country. The research objectives that this paper seeks to answer are (1) how the existing energy- climate change policies and legal frameworks are influencing renewable energy technology adoption and (2) how the increase in renewable energy in the energy mix impacts carbon emission and achieving the national determined contribution goal. Data were collected through interviews from identified key informants. The findings showed that government involvement through policies has significantly led to the increase in adoption of renewable energy technologies in the country. It was determined that clean energy technologies across the country has increased to 14% by 2016 after implementation of various energy policies. Additionally, the increase of renewable energy sources in the national generating mix is modeled to have a significant reduction in greenhouse emissions in the country. The low-carbon scenario model estimates that emissions would be reduced to 0.1 metric tonnes by 2040 based on the government's energy target plans. It was concluded that clean and affordable energy is vital but there is a need for public consultations and awareness of new infrastructure that come with energy transition as this plays a key role in the achievement of sustainable development goals in Kenya.

**Keywords:** *Energy transition; renewable energy technologies; green economy*

**Cite as:** *Ngugi and Nzioka, (2021).* Evaluation of policies as drivers of energy transition and modelling of a low carbon emission scenario for the energy generation sector in Kenya. *East African Journal of Science, Technology and Innovation 2 (Special Issue).*

Received: 24/04/21
Accepted: 13/05/21
Published: 25/05/21

## Introduction

Green economic growth continues to be on the agenda of both developed and developing countries, as they aim at aligning and restructuring the countries growth models towards sustainable development (Ngoc & Anh, 2016). The level of industrialization and economic development of any country relies heavily on the availability and reliability of energy. This is because energy is the driving force of all economies globally (Ngoc & Anh, 2016). Currently, most economies across the world rely heavily on fossil fuel as a source of energy which has led to an increase in the number of pollutants, greenhouses gases, and waste.

Energy transition is considered as the transformation of the world's economies from fossil-based energy systems to low-carbon economies by the next half-century (IRENA,

2018). Flexibility in the energy systems is considered the most effective way of ensuring that energy transition is adopted across the globe (Taibi, 2018). This has led to the evolution of renewable energy generation, distribution, transmission, storage, and demand-side management. In the traditional conventional supply system, renewables such as hydropower have been easier to incorporate. However, flexibility in the energy systems has been seen to increase the use of renewable energy sources such as solar and wind, therefore, increasing the percentage of renewable energy into the grid. This, therefore means that the transition to renewable energy sources continues to play a vital role in promoting green economies.

Despite the different theories surrounding the cause of climate change, the world continues to face devastating environmental impacts such as the change in rainfall patterns, rise in sea levels, melting of ice caps, and loss of fauna and flora. Historically, economies were designed to rely heavily on the production of raw materials. This continues to cause environmental degradation and depletion of resources. In the bid to reduce emissions such as greenhouse gases (GHGs) and implement actions that will promote sustainable development, the Paris agreement was signed in 2016, which will see signatory parties voluntarily implement their Nationally Determined Contributions and mitigate their greenhouse gas emissions. The transition and adoption of renewable energy sources are some of the mitigation measures adopted to reduce GHG'-s across the world. The transformation to zero carbon (IV) oxide economies is aimed at creating green economies that are more sustainable.

African countries' economies have been affected greatly by climate change since they are highly dependent on their agricultural sector. To ensure that they do not lose a portion of their GDP, countries such as Ethiopia have set action plans that will see them transform their agricultural and energy sectors to green economies (Sida, 2017). Tanzania has rolled out the Southern Agriculture Growth Corridor of Tanzania (SAGCOT) initiative which is aimed at transforming the country's agricultural sector by changing it to an "agricultural green growth industry" by ensuring smallholders gain benefit from the programme (Mihayo & Swai, 2019).

Kenya through the Green Economy Strategy and Implementation Plan (GESIP 2016-2030) aims at achieving sustainable development by ensuring proper management of existing resources while building sustainable infrastructure that will transform the country into a low-carbon economy (Ministry of Environment and Natural resources, 2016). The agriculture sector contributes 26 percent of the country's Gross Domestic Product (GDP) while providing employment both directly and indirectly to the population (FAO, 2020). In 2018, the agricultural sector grew by 6.6 percent, with the horticultural sector contributing 153 million shillings of the 497 billion shillings of total income (KNBS, 2019). Horticultural production remains highly reliant on energy use during its various stages of production such as irrigation, harvesting, storage, transportation and there is a need to cooperate energy-efficient technologies in the sector (UNDP, 2009).

The vital role that tracking of energy generation and consumption play in ensuring the transition to green economies cannot be understated. Musango *et al.* models how the different scenarios arise from the use of efficient technologies in the different sectors of the economy such as water, energy, and agriculture, and how it will impact green economy investment in South Africa (Musango, Brent, & Bassi, 2014). According to the KNBS report 2019, Kenya's agricultural sector consumed 59 thousand tonnes of petroleum fuels in 2018; this was an increase from 57.4 tonnes in 2017, exclusive of the energy consumed from the grid to facilitate other activities such as processing and storage of produce (KNBS, 2019).

Reliable and affordable energy supply is key for the growth of agriculture and renewable energy seeks to provide a green energy alternative option. It is for this reason that policymakers continue to push for energy transition as it is seen as a way to meet the increasing energy demand with the use of modern renewable energy technologies such as solar pumps, solar PV, and wind-related technologies while also advocating for the adoption of energy efficiency measures (Katikiro, 2016). The technological and economic change that arise from renewable energy technologies pose a great challenge to policy

makers. It is for this reason that it is vital to analyze policy impacts with the aim of determining how different policy instruments influence renewable energy transition adoption and pathways (Say & Rosano, 2019).

This study, therefore, seeks to assess how existing energy and climate change policies are influencing renewable energy technology adoption in Kenya's energy sector and model a low-carbon energy scenario for the country based on the increase of renewable energy sources in the energy mix and how this reflects on the achievement the national determined contribution goal.

***Biomass***

The most common form of biomass energy is fuelwood, charcoal, agricultural waste, and biogas which are largely uncommercialized, especially in rural areas.

Kenya has a forest cover of 7% which includes both the indigenous and planted forests (Trading Economics, 2020). The protected forests are closed and their use is usually restricted and controlled as they form the main water towers for Kenya. Obtaining trees from these zones is usually supervised to ensure conservation while firewood is easily accessible in the arid zones which leads to unsustainable harvesting methods. Production of charcoal is done in inefficient kilns thus causing air pollution (Okutoyi, 2020). Due to the increased logging for timber use and charcoal production, most of the forest cover has significantly reduced thus efforts have been made to protect to restore the forest cover.

***Biogas***

The generation of biogas in Kenya remains completely untapped however, various projects have been up and running after successful installation. They include Naivasha gorge farm plant produces for its use while the surplus energy of 2MW is included in the national grid. Other biogas projects include the Dagoretti biogas plant that produces 30KW and the Kilifi sisal plantation(15KW). According to Eipa et.al, 2019, he highlighted that the use of biogas has a positive contribution in the mitigation of climate change impacts due to the low level of methane emissions released during burning (Eipa, Nganga, & Muthama, 2019).

***Agricultural waste***

The use of sugar cane and coffee waste to produce energy is being exploited in the country. The use of bagasse in sugar cane companies to power boilers has been seen as a sustainable way to reduce electrical bills. Sugar companies such as Mumias have been able to produce substantial energy from their sugar waste and add it to the national grid (United Nation Environment Programme, 2019). The field is also growing, attracting even private investors such as Lean Energy Solutions who use coffee waste to generate electricity, with the country economic backbone is dependent on agriculture; the availability of agricultural waste is easy.

***Bio-fuels***

Kenya has not tapped into biofuels for energy production, however, there have been prospects and pilot projects through research using jatropha plants and more recently hyacinth weed. Production of biodiesel and ethanol is done at a minimal level. the full exploitation of biofuels in Kenya remains relatively untapped. Investors in biofuels, such as KOKO networks who are at the deployment stage of development, continue to enjoy relative support from the government to penetrate the market and supply to the urban users (Biofuels International, 2019). Additionally, the government is supporting efforts and research towards its development of biofuels.

***Solar energy***

All parts of the country receive high solar insolation, with the average daily insolation in the country estimated to be 4-6kWh/$m^2$. Recent studies show that around 700MW of solar potential in the country is viable. The government commissioned a solar power project in Garrisa that is estimated to generate 50MW from the 200,000 solar panels installed. The project is to contribute 2% to the energy mix (REA, 2020). Additionally, the Rural Electrification and Renewable Energy Corporation has pioneered the installation of PV solar systems in off the grid households through the M-KOPA system comprises of the 8W solar panel, a USB charger, a rechargeable LED torch, a radio, and 2 LED bulbs.

Additionally, the government has put in effort in encouraging solar energy innovation by removing the Value Added Tax and ensuring zero-rated the import duty on the equipment and resources associated with renewable energy.

***Geothermal***

Kenya is currently the largest geothermal energy producer in Africa and produces about 828.4 MW from its five commissioned plants (Thairu, 2020). The potential from geothermal sources in the country is estimated to be 10GW. The government has set up plans for generating 5000MW by 2030 to transform the country into a low carbon economy (Rosen, 2018). To attract investors, the government with the support of other financiers has de-risked geothermal exploitation by identifying potential geothermal well sights and sell the steam to independent power producers (IPP's) (Johnson & Ogeya, 2018). The Olkaria plant was first commissioned in 1981 that has a capacity of 15MW, with other similar units being commissioned in 1982 and 1985 bring the total capacity to of Olkaria I to 45 MW. Olkaria II which has a total capacity of 105 MW was commissioned in 2003. The Ormat-Orpower is an IPP that was given Olkaria III with a capacity of 100MW, Olkaria IV which is under Ken Gen adds capacity of 280 MW (Campen & Rai, 2015). Olkaria V that has two units each with a net capacity of 82.7 MW, a total capacity of 165.4 MW was commissioned in 2019 (GDC, 2020).

***Wind***

The country has a potential of 3000MW generation from wind energy potential of as high as 346W/m$^2$. The wind speed in areas such as Marsabit, Kajiado, Laikipia Lamu, and Isiolo have speeds of over 6m/s (Ministry of Energy, 2018). Currently, the Lake Turkana Wind Power project located in Marsabit County was commissioned and is expected to supply 310MW of electricity into the national grid. The Ngong Hills wind farm produces 25.5 MW of electricity.

***Hydro-power energy***

Hydroelectric power accounts to close to 40% of the energy supply in Kenya producing 872MW (Ministry of Energy, 2018). The main hydropower production stations include; the Seven Forks Dam on Tana River, Sondu-Miriu in Western Kenya, Turkwel Gorge in North West. Kenya has been facing the climate change effects in the last two decades, which has contributed to the high level of drought and poor rains in the country and the low amount of water being feed into the dams channeled into the dams for HEP production.

In the country, most of the potential for small hydro is located within the five main drainage basins. Currently, the government has projects that produce 11.7 MW while 5.81MW comes from a small hydro project run by private developers.

***Oil***

Kenya relies heavily on fossil fuel for its operations in the industrial and transport sector. The country has 10 operating thermal plants injecting 695.5 MW into the national grid (Kwame, 2020). The importation of oil in the country has however faced numerous challenges. These include sabotage of pipelines, oil spills, corruption of officials, oil refineries by-products and even shutting down of the oil refineries station. In 2012, oil reserves, that contain 300 and 350 API gravity were discovered in the North-Western part of the country, Ngamia 1 by Tullow Oil. Other wells have been drilled at like Etuko-1, Twiga-1, Ekales-1, Paipai-1, Amosing-1, Agete-1, and Awoi-six locations with six of them having oil (Ochanda, 2014). The reserves are estimated to be more than 1 billion barrels with new sites being explored. The revenue from oil exploration is close to 9 billion a year and thus a significant boost to the economy.

The biggest challenge yet for the oil sector in Kenya is that it lacks the infrastructure for oil production and exportation on a large-scale level. With the areas of discovery being remote and with poor infrastructure, the oil has to be transported through trucks to the nearest port which is 850km away. Also, there has been confusion and wrangles from the residents that the revenues from the oil should be shared and included in their regional budget to boost development in the area. Oil which has been predominantly debated as either a curse or a blessing in many nations has now a direct bearing on the development of the marginalized Northwest part of the country. However, according to Ang'u *et al*., 2019, the reduction in oil dependance for its intended use of energy generation will reduce the emergency of civil

unrest, therefore, reducing the global oil price shocks being experienced.

*Coal*

Coal reserves have been discovered in the Kwasasi area, Lamu County, and Mui Basin, Kitui County. In Lamu County, a coal-fired thermal plant that is estimated to produce 1050 MW is to be constructed. The project site operator Amu Power plant; has estimated that close to 3 million tonnes of coal will be burned annually for the production of energy which will, in turn, be added to the national grid (Otieno, 2018). Despite the great benefits that are to be derived from the exploration of coal in the country, environmentalists, both international and local, and the residents of the area have strongly raised their objections against the construction of the proposed project and the extraction and use of coal in the country. They argue that the impacts of the extraction of the coal in the country will be detrimental to the society's health, and the environment. Their grievances are centered on the fact that these impacts will affect not only the current generation but also the next generation. This opposition has led to the stalling of the 2-billion-dollar project to date as consultations about the project continue to wedge on.

The case is also not different in Mui Basin, Kitui County where an estimated 400 million tonnes of coal reserves are yet to be exploited (Mutua, 2018). The exploration of this site is set to contribute 1000 MW of energy into the national grid (Ochanda, 2014) but the matter is at an impasse with the locals exercising their public participation rights through the Environmental Impact Assessment (EIA) report process and refusing to accent to the project. The research did also emphasize the importance of carrying out further studies on the spatial distribution of air pollutants in the region. Muthama *et.al*, 2015, in their work gives a clear analysis of the wind patterns in the area, and of how a high level of high particulate matter being dispersed in the area will affect those living in the north and northwest part of the proposed coal mining project thus leading to direct health impacts especially respiratory-related diseases (Muthama, Kaume, Mutai, & Nganga, 2015).

*Nuclear energy*

Kenya continues to have an interest in nuclear energy which has led to the formation of the Kenya Nuclear Electricity Board. The country has expectations of producing energy from nuclear sources by the year 2030. An estimate of 1,000MW is expected to be generated by 2030 added to the national grid (Herbling, 2020).

**Materials and Methods**

The energy sector is highly influenced by the use of models that assist policy-makers to formulate favorable policies. This is because models are designed to forecast the effects of set policies on energy demand, energy generated, emissions, and relation to the economy (SEI, 2002). This study used the Long-range Energy Alternative Planning System (LEAP) modeling tool to determine how the existing and new energy policies will affect the level of renewable energy technologies adoption into the country's national grid and how this affects the level of greenhouse emission gases into the environment. LEAP is an integrated modeling tool used to track energy consumption and resource extraction, tracking GHGs in all sectors of the economy.

The field of energy, environment, and climate change in Kenya has a diverse set of policies that are used to govern the sectors and identifying problems which usually requires a high investment of time and resources. The study analyzed policies from the three sectors, of energy, environment, and climate change that are aimed at contributing towards the adoption of renewable energy technologies in the country to identify barriers and gaps existing. The policies were derived from the institutional website where they had been made publicly available. The reviewed policies included; The Energy Act 2006, revised 2019, The Energy (Solar Photovoltaic Systems) Regulations 2012, Geothermal Resource Act, (1982) Revised 2012, Climate Change Act, 2016, Forest Conservation and Management Act 2016, National policy on climate finance 2016, East Africa Community Climate Change Policy (EACCP), Environment Management Coordination Act (EMCA) Cap 387, Air quality 2014, Additionally, seven key informants from various energy and environmental institutions were interviewed and

engaged to help gather purposive data to help identify the existing gaps in the policies. The informants were picked from; The National Environment Management Authority (NEMA)-climate change department, Environmental Impact Assessment department, National Implementing Entity/ adaptation fund department, The Green Growth Employment Programme- Danida initiative, Rural Electrification and Renewable Energy Cooperation (REREC).

To carry out the a low-carbon energy generation scenario using the LEAP software credible and reliable data was obtained from the Kenya National Bureau of Statistics (KNBS), CEIC platform: https://www.ceicdata.com/en and en ergy resource data from energy institutions such as Rural Electrification and Renewable Energy Cooperation (REREC). The data consists of electricity generation capacity by source, electricity installed capacity by source, energy generation from different energy sources, electricity consumption, electricity transmission, and distribution.

**Results**

This section discusses the results obtained during the research process. The results answered the question of how existing energy and climate change policies are influencing renewable energy technology adoption in Kenya's energy sector. The research went ahead to model a low-carbon emission scenario for the energy generation sector in Kenya as new renewable energy sources are included in the energy mix.

***Policies influencing renewable energy technology adoption***

***The Energy Act 2006, revised 2019***

The policy promotes the use of renewable energy technologies in the country in various areas such as biomass, biodiesel, bioethanol, charcoal, fuelwood, solar, wind, tidal waves, hydropower, biogas, and municipal waste. The policy has been promoting clean development mechanism in all renewable energy sources (Ministry of Energy, 2006). To encourage renewable energy, use the government has introduced zero-rated import duty and removed VAT on renewable energy equipment and accessories.

***The Energy (Solar Photovoltaic Systems) Regulations 2012***

The policy gives guidelines on the licensing of solar PV technicians, manufacturers, vendors, contractors, and importers. Each of the shareholders on the listed above should be licensed by the energy commission.

***Geothermal Resource Act, (1982) Revised 2012***

The Geothermal sector is governed by the Geothermal Resource Act of 1982, which stipulates that all geothermal resources that are unextracted are all vested in the Government of Kenya. Any unauthorized use of geothermal resources without proper licensing is prohibited. All licenses will be obtained from the Ministry of Energy, allowing the investor to explore the resources for a period not exceeding five years and later subjected under review if all conditions are fulfilled (Laws of Kenya, 2012).

***Forest Conservation and Management Act 2016***

The policy aims at protecting conserving forests irrespective of if it's as public, community, or private forest. It stipulates that that incentives such as exemption of land rates once the piece of land has been established as a private forest and a penalty that might either include imprisonment or be fine (Forest, 2016). Currently, the country has achieved a 7.4% forest cover which is below the required 10% global minimum requirement. Biomass is the main source of energy for both urban and rural households in Kenya which is putting a strain on the existing forest reserves. Wood and charcoal are used mostly for cooking in many households in the country. This has led to large scale illegal logging and encroachment of public and community forests.

***Climate Change Act, 2016***

The Act is aimed at developing, managing, implementing, and regulating mechanisms that are advocating for climate change resilience and low carbon development. A National Climate Change Action Plan that has been formulated is aimed at ensuring that mainstreaming, adaption, mitigating efforts that will reduce the risk of climate change in the country are enforced (Ministry of Environment, 2016).

***National policy on climate finance 2016***

The policy is aimed at giving guidelines, legal and institutional framework that will ensure

betteraccess to climate finance. The policy which is in line with the Paris Agreement by all parties will guide the country in mobilizing finances that will help tackle climate change goals set under the National Determined Contribution (NDC) (Ministry of Environment, 2016). The UNFCCC gives guidelines that inform this policy on how reporting of financial resources will be done in the member countries.

The country has been using different market-based approaches under the Paris Agreement to reduce the GHG emissions in the country. The country has a Clean Development Mechanism (CDM) projects ongoing and various voluntary carbon market projects. Table 1 outlines the different energy projects currently running the country that are under the Clean Development Mechanism and what amount of $CO_2$ metric tonnes each project reduces annually.

*Table 1. The current energy-related CDM projects running in the country*

| **Program/ Project** | **Sectoral scope** | **The estimated amount of $CO_2$ reduction metric tons annually** |
|---|---|---|
| Kenya improved woodstoves project | Energy | 42,257 |
| KOKO Kenya- Ethanol cookstoves | Renewable energy industry | 1 |
| Geothermal Project -Olkaria IV | Renewable energy | 651,349 |
| Geothermal project – Olkaria III | Renewable energy | 177600 |
| Aberdare range | Afforestation and reforestation | 8542 |
| Karan biofuel – bio residues briquettes supply for industrial steam production | Renewable energy | 43,699 |
| Efficient cookstove program | Energy | 50, 761 |
| Kenya solar lighting | Renewable energy and energy distribution | |
| Kenya Ecoeye | Renewable | 21,491 |
| Restoration of degraded lands through | Afforestation and reforestation | 18,571 |
| Geothermal Olkaria 11 | Energy | 149,632 |
| 60MW Kinangop Wind Park Project | Energy renewables | 121,036 |
| James Finlay Improved cookstoves | Renewables | 81,975 |
| ACES- Biogas KENFAP | Renewables | 63,934 |
| Greenlight for Africa | | 31,099 |
| Lake Turkana 310 MW wind project | Energy renewables | 736,615 |
| Efficient cookstove program Eldoret East and Keiyo district | Renewables | 50,761 |
| Ngong hills wind electricity | Energy | 9,941 |
| Kenya Samsung Mombasa project | Renewables | 107,457 |
| Bio-Lite Improved cookstoves program | Energy demand | 49,023 |
| Re-development of Tana Hydropower | Energy (renewables) | 25,680 |

Source: UNFCCC: https://unfccc.int/gcse?q=kenya, 2020

***East Africa Community Climate Change Policy (EACCP)***

The EACCP policy which includes Kenya, Burundi, Uganda, Rwanda, and the United Republic of Tanzania as partner states is aimed at ensuring that the region develops and engages a more inclusive and strategic approach in responding to climate change impacts. The policy prioritizes climate change adaptation, mitigation, and research that will reduce the vulnerability of the region. The policy covers several sectors such as energy, agriculture, livestock, forestry, water land, and health. In the bid of reducing GHG gases emission in the energy sector, the policy advocates for use of the vast renewable energy resources in the region that are less susceptible and vulnerable to climate change. This encourages the diversification of energy sources into the energy grid while changing energy policy sectors through financial incentives and promotion of research. Additionally, afforestation and re-afforestation measures are being advocated which will contribute to carbon sequestration; with energy efficiency measures being in-cooperated in the national programs.

***Environment Management Coordination Act (EMCA) Cap 387***

The Act entitles every person in Kenya to a clean and healthy environment to safeguard the environment. The Act gives guidelines on issues of environment stipulating which offenses and penalties are to be charged in the case of contravening the Act. The Act also gives guidelines on how a proponent should conduct an Environmental Impact Assessment (EIA) which will analyze the project's impact on a social, economic, and environmental scope before the commencement of any project. The EIA license is a requirement when carrying out all energy projects in the country to ensure that all projects benefit out-weigh the cost of implementing the project. The act also focuses on how to control emissions by providing emission standards and ways to reduce emissions from sources. Control of $CO_2$ emission from motor vehicles and industries has been one of the key areas of focus.

***Determining policies influence in the adoption of renewable energy technologies***

***Financial incentives***

The Energy Act 2006, and The Energy (Solar Photovoltaic Systems) Regulations 2012 use price driven incentives such as zero-rated import duty and no VAT on renewable energy equipment as a way of encouraging customers to purchase renewable energy technologies especially solar based technologies.

Figure 1 shows that the percentage of clean technologies has been on the rise in the country from 2% in 2000 to 13% in 2016. This is especially so in the use of efficient lighting appliances, promotion in use of solar based technologies and improved cooking stoves in the country. Financial incentives are considered one of the key drivers to the customers preference in adopting clean technologies in the country with many of the users preferring technologies that will reduce their energy cost.

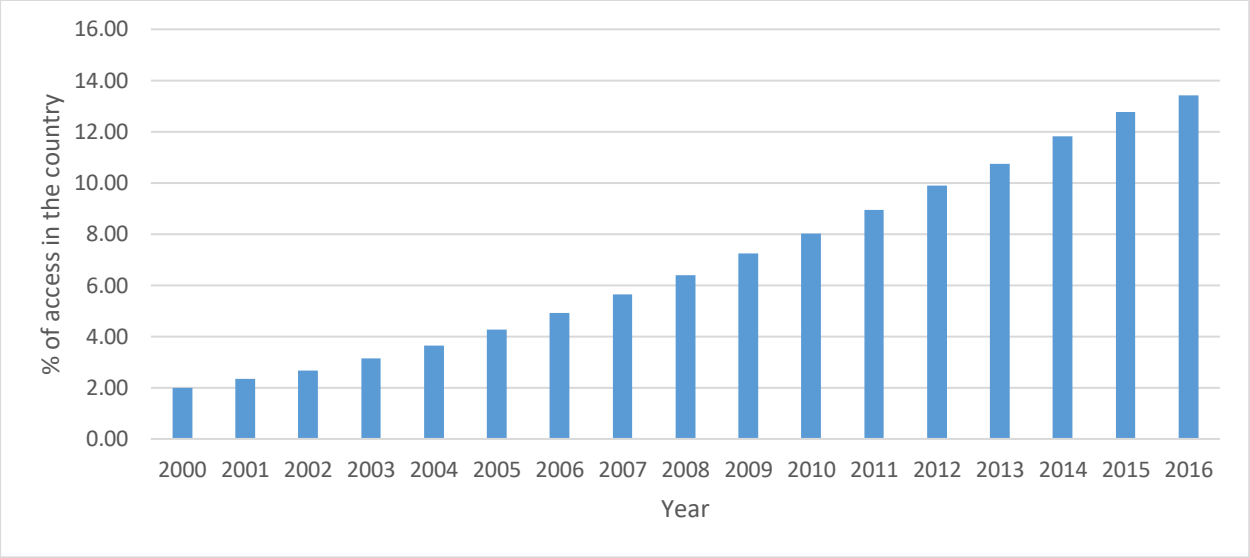



*Figure 1. Percentage change in clean fuels and technology Data source: World Bank, 2020*

***Role of institutional framework***

Different institutions have been tasked with the responsibility of carrying out different mandates in the energy sector as outlined in the Energy Act 2006. Rural Electrification and Renewable Energy Cooperation, REREC, is tasked with the responsibility of spearheading the implementation of rural electrification projects across the country to drive social-economic transformation and drive the adoption of green energy across the country. The Geothermal Development Cooperation (GDC), is the institution tasked with the responsibility of developing steam filed and then selling geothermal steam to private investors and the Kenya Electricity Generation Company (KenGen).

Institutional unbundling of the energy and environmental sector has led to formation of independent utility organizations. The REREC, has been implementing projects such as the school solar installation program. By 2018 the project implementation has seen an increase in the number of solar PV installations in primary schools and installation of mini-grids across the counties to increase access to electricity among the rural areas. Reform in the geothermal sector has led to the entry of Independent Power Producers that have seen an increase in electricity production from geothermal sources into the energy mix.

To ensure effective enforcement of environmental matters the National Environmental Management Authority (NEMA), has the task of monitoring, investigating, and reporting companies that are compliant with their climate change duties. This has led to the country addressing environmental issues efficiently.

***Stakeholder involvement***

Entry of Independent Power Producers in the energy sector has seen to the increase of geothermal energy sources into the energy mix. This has been greatly influenced by the revision of the Geothermal Resource Act, (1982). The chart below, figure 2, shows how the production of electricity has been increasing over the years that is from 2006 to 2019. By November 2019 the electricity production from geothermal sources was 5234.65 GW/year which compared to January 2006 was 1045.69GW/year.

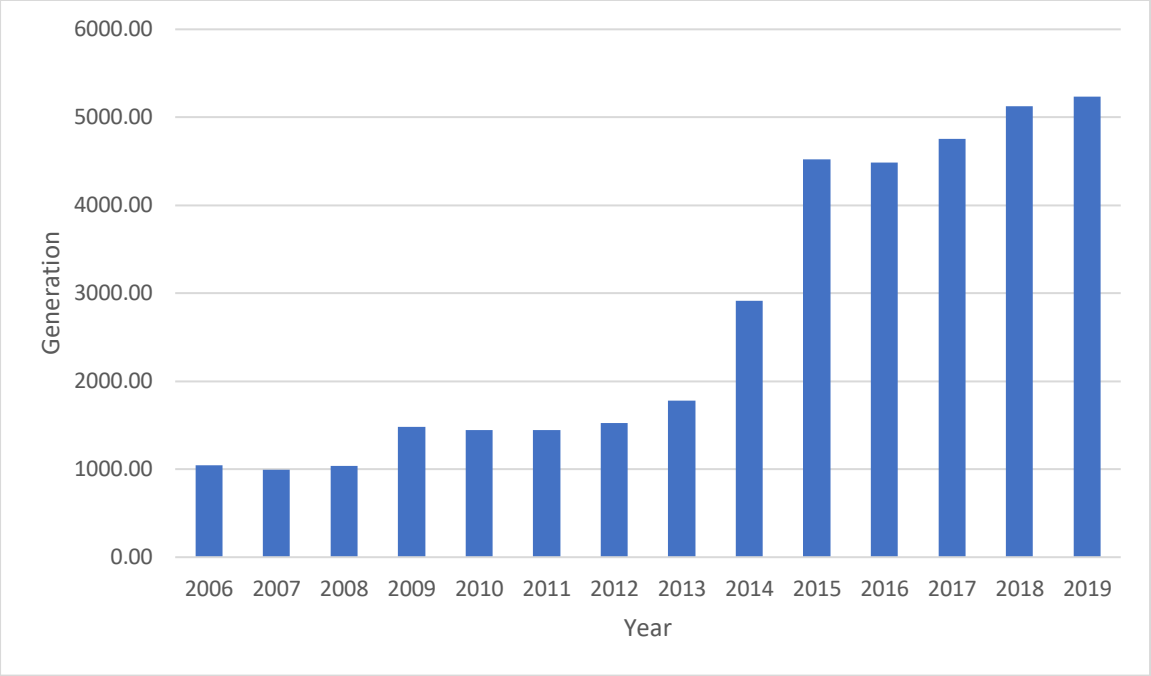



*Figure 2. Geothermal electricity production time-series data source: KNBS 2020*

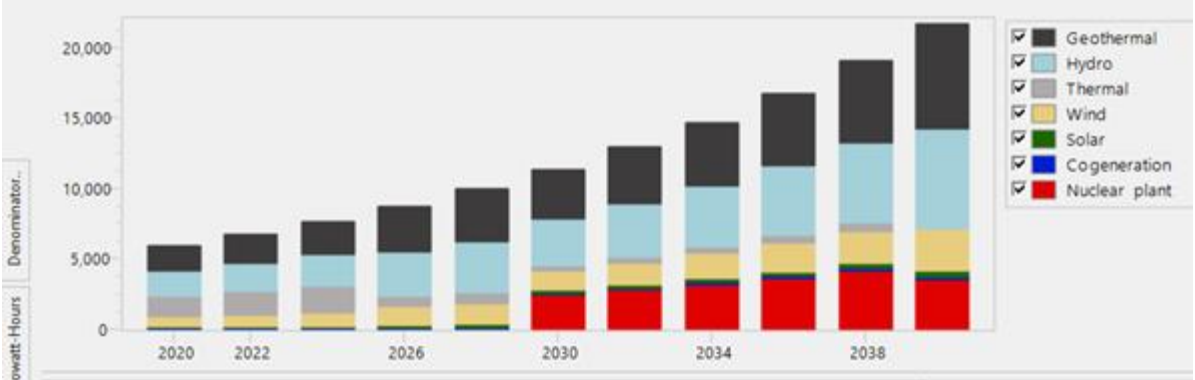
***Financial mobilization***

The importance of financial resources in the adoption of green technologies is greatly being advocated in the Climate Change Act, 2016 and East Africa Community Climate Change Policy (EACCP). The involvement of different stakeholders such as international bodies, Non-Governmental Organizations such as CAFOD, Community based organizations, and governmental organizations such as NETFUND have been financially supporting efforts, projects, and research that will improve clean energy technologies in the country. Table 1, clearly outlines ongoing energy projects in the country that receive financial support from different stakeholders during their research, implementation and deployment stage.

The Forest Conservation and Management Act 2016 policy is set in line with the Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiative which is designed to create financial value for the carbon stored in forests by granting developing countries incentives to reduce emissions.

***Electricity generation low-carbon emission scenario***

Figure 3 modeled through the LEAP software, illustrates how energy generation in the country will change from 2020 to 2040 based on the existing and planned energy projects injected into the national grid. Energy policies such as the Energy Act and the Geothermal energy resource act, are aimed at deploying clean energy technologies in the country and ensuring a smooth green economy transition. The decommissioning of all diesel thermal power plants by the year 2034, and setting up of new geothermal, wind, solar power plants is aimed at increasing electricity production from renewable sources. The government has laid down plans that will see to the commissioning of various energy projects into the national power grid to supply the ever-increasing demand.




| Branches | 2020 | 2022 | 2024 | 2026 | 2028 | 2030 | 2032 | 2034 | 2036 | 2038 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hydro | 1,754.6 | 1,997.5 | 2,274.1 | 3,164.7 | 3,602.9 | 3,361.6 | 3,827.1 | 4,357.0 | 4,960.3 | 5,647.2 | 7,177.3 |
| Thermal | 1,479.9 | 1,684.8 | 1,918.1 | 722.0 | 822.0 | 367.2 | 418.0 | 475.9 | 541.8 | 616.8 | - |
| Wind | 713.3 | 812.1 | 924.5 | 1,286.6 | 1,464.8 | 1,366.7 | 1,555.9 | 1,771.4 | 2,016.6 | 2,295.9 | 2,917.9 |
| Solar | 106.5 | 121.2 | 138.0 | 192.0 | 218.6 | 204.0 | 232.2 | 264.4 | 301.0 | 342.7 | 435.5 |
| Cogeneration | 59.6 | 67.9 | 77.3 | 107.5 | 122.4 | 114.2 | 130.0 | 148.1 | 168.6 | 191.9 | 243.9 |
| Nuclear plant | - | - | - | - | - | 2,447.8 | 2,786.7 | 3,172.6 | 3,611.9 | 4,112.0 | 3,484.1 |
| Total | 5,934.5 | 6,756.2 | 7,691.7 | 8,756.7 | 9,969.2 | 11,349.6 | 12,921.1 | 14,710.3 | 16,747.1 | 19,066.0 | 21,706.0 |

*Figure 3. Energy generation forecasting*

By the year 2040, the government has outlined the commissioning of new geothermal power plants, a total capacity of 2400 MW, nuclear power plant 1000MW, solar 40 MW with wind and hydro increasing their capacity by 738MW each.

According to Figure 4, the results of how the increase in renewable energy sources into the generation grid will affect $CO_2$ and other greenhouse gas emissions from point of generation. The chart forecasts that as renewable sources increase and thermal sources are decommissioned, the level of emission decrease from 0.4 metric tonnes of $CO_2$ equivalent from point of emission to 0.1 metric tonnes of $CO_2$ equivalent if other thermal plant and coal sources are not commissioned.

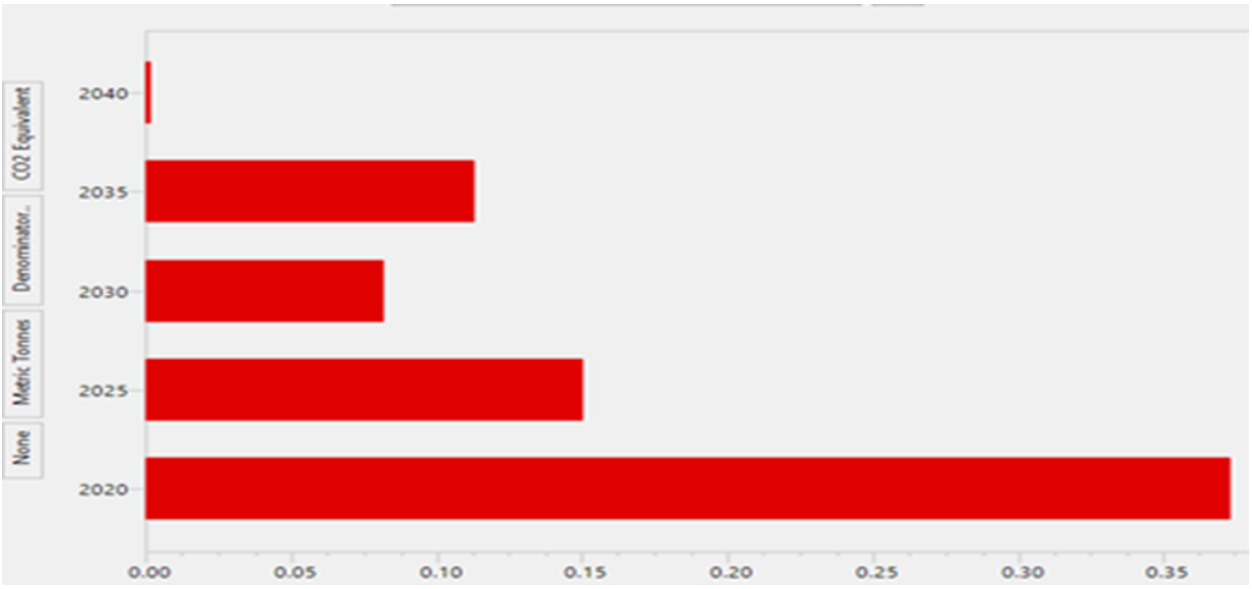



*Figure 4. Emissions forecast from all generation source. Data source: Author, 2020*

**Discussion**

The results show how government involvement in the energy and environmental sector has influenced formulation of policies that encourage the use renewable energy technologies in the country. Price driven incentives such as tax relief and tax exemption for solar based technologies have been considered effective ways to encourage consumers to adopt renewables. Establishing institutional frameworks that have eased the process and procedures of acquiring has been made possible due to the unbundling of institutions in the energy and environmental sector.

Kenya, which is part of the Paris agreement signed in 2016, has been setting down efforts with the aim of affirming its commitment to action by availing its National Determined Contribution (NDC) targets. The dependency and use of geothermal energy sources for electricity generation have been steadily increasing in the country due to the vulnerability of hydropower caused by effects of global warming. The increase of renewable energy sources into the energy generation mix is one of the governments initiatives in reducing its emissions as energy is considered one of the target sources. The reduction of emissions from energy generating sources in the country by 2040 to 0.1 metric tonnes as predicted in the low carbon emission scenario modeled will see to the country making strides in achieving it National Determined Contribution (NDC) target.

**Conclusion**

The agriculture sector continues to play a major role when it comes to energy demand and greenhouse emission. Energy transition in the irrigation, processing, and storage sector of the horticulture industry will help drive the sector to a green industry. The country has implemented various policies in both energy and climate change disciplines. It was noted that the existing policies such as The Energy Act, The Energy (Solar Photovoltaic Systems) Regulations 2012, which has encouraged the installation of solar appliances used in the horticulture for purpose of irrigation and refrigeration storage are encouraging energy transition. The increase of renewable sources into the generation mix is forecasted to drive the country to a low carbon economy and this will have a direct impact on reducing the carbon footprint. Despite all these efforts there is a need for reforms that will address the institutional, and enforcement barriers identified in the policies.

**Recommendations**

The goal of transforming Kenya into a green economy requires stringent and strict measures that will encourage the transition to renewables in the generation mix. It is also vital to enforcing energy policies that will increase energy efficiency and the adoption of renewable energy technologies in all sectors. To achieve this we suggest that there is a need for public sensitization and awareness on matters of renewable energy technologies and energy efficiency measures to encourage households to adopt and integrate them into their day-to-day energy use. In addition, there should be public involvement and consultation when setting up renewable projects to encourage project ownership. Institutions should be equipped with well-trained staff to ensure that the mandates of the energy and climate change organizations are achieved.

**References**


Abaza, H. (2010, August). *Green Economy in Action.* Retrieved from United Nation Development Programme: https://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/mainstreaming/Green%20Economy%20in%20Action/Green%20Economy%20Compilation%20Report.pdf

Abid, Z., Abid, M., Zafar, Q., & Mehmood, S. (2018). Detrimental Effects of Climate Change on Wome. *Springer*, 537-551.

AFDB. (2015, September 17). *Lake Turukana Wind Power Project: The largest wind farm project in Africa.* Retrieved from African Development Bank Group:

https://www.afdb.org/en/projects-and-operations/selected-projects/lake-turkana-wind-power-project-the-largest-wind-farm-project-in-africa-143

Affairs, I. o. (2015). *Situational Analysis of Energy Industry Policy & Strategy for Kenya.* Nairobi: Institute of Economic Affairs.

AJODO-ADEBANJOKO, N. (2017). *Towards ending conflict and insecurity in the Niger Delta region.* African Centre for the Constructive Resolution of Disputes.

Akermi, R., & Triki, A. (2017). The green energy transition and civil society in Tunisia: Action, motivations and barriers. *Elsevier ltd*, 79-84.

Aliyu, A. K., Modu, B., & Tan, C. W. (2017). A review of reneable energy development in Africa: A focus in South Africa, Egypt and Nigeria. *Elsevier*.

Allen, E., & Lyons, H. (2019). Women's leadership in renewable transformation, energy justice and energy democracy: Redistributing power. *Elsevier*.

Allison, J. E., McCroryb, K., & Oxnevadc, I. (2019). Closing the renewable energy gender gap in the United States and Canada: The role of women's professional networking. *Elsevier*, 35-45.

Ang'u, C., N. J., Oludhe, C., & Kong'ani, L. N. (2019). Effects of Civil Conflicts on Global Oil Prices and their Impact on the Energy Sector. *Journal of Sustainability, Environment and Peace*, 12-18.

Ansah, R. H., & Sorooshian, S. (2019). Green economy: Private sectors' response to climate change. *Wiley Periodicals Inc*, 63-69.

Awoponea, A. K., Zobaaa, A. F., & Banuenumah, W. (2017). Techno-economic and environmental analysis of power generation expansion plan of Ghana. *Elsevier*, 13-22.

AZEROUAL, M., & Aboubakr EL MAKRINI, H. E. (2018). Renewable Energy Potential and Avaliable Capacity for Wind and Solar in Morocco towards 2030. *Engineering Science and Technology Review*, 189-198.

Babugura, A. A. (2016). Children, Young People, and Climate Change: A Gender Perspective. *Springer Science*.

Bagheri, M., Alivand, M. S., & Alikarami, M. (2019). Developing a multiple-criteria decision analysis for green economy transition: a Canadian case study. *Economic Systems Research*.

Berg, H. V. (2016). Economic Growth and Development. *World Scientific*.

Biofuels International. (2019, March 13). *Biofuel ATM launcheds in Kenya*. Retrieved from Biofuels International: https://biofuels-news.com/news/biofuel-atm-launches-in-kenya/

Botelhoa, A., Pinto, L. M., Lourenço-Gomesc, L., & Valented, M. (2016). Public perceptions of environmental friendliness of renewable. *Elsevier*, 73-86.

C.M.C . (2020). *Kimwarer Multipurpose Dam Project*. Retrieved from Cooperative Muratori & Cementisti di Ravenna Societa Cooperative: https://cmcgruppo.com/cmc/en/project/kithino-multipurpose-dam-project/

Campen, B. V., & Rai, K. (2015). Geothermal Policy and Regulation - Cases from Chile, Kenya, New Zealand and the Philippines. *ResearchGate*.

Challenges, W. a. (2011). *Anita L. Wenden.* New York: Springer .

Charbit, Y. (2018). Women As Actors in Addressing Climate Change. *Springer Science*, 317-328.

Choukri, K., Naddami, A., & Hayani, S. (2017). *Renewable energy in emerging countries: lessons from energy transition in Morocco.* Springer Open.

Cormack, Z. (2019, September 3). *Kenya's huge wind power project might be great for the environment but not for local communities*. Retrieved from Quartz Africa: https://qz.com/africa/1700925/kenyas-huge-wind-power-project-in-turkana-hurts-local-people/

East Africa Wild Life Society. (2019, October 11). *Win for Renewable Energy, Loss for Lamu Coal Power Plant Project*. Retrieved from The East African Wild Life Society: https://eawildlife.org/win-for-renewable-energy-loss-for-lamu-coal-power-plant-project/

Ebiede, T. M., & Langer, A. (2017, March 8). *How amnesty efforts in the Niger Delta triggered new violence*. Retrieved from The

Conversation: https://theconversation.com/how-amnesty-efforts-in-the-niger-delta-triggered-new-violence-74085

Eipa, S. J., Nganga, J. K., & Muthama, a. N. (2019). Utilization of Livestock Manure Based Biogas for Climate Change Mitigation in Nakuru County, Kenya. *Journal of Sustainability, Environment and Peace*, 39-44.

El-Khyat, M. M., & Ameen, E. E. (2011). Renewable energy in Egypt- challenges and prospects. *ResearchGate*.

Elum, Z., Mopip, K., & Henri-Ukaha. (2016). Oil expolitation and its socioeconomic effects on the Niger Delta region of Nigeria. *SpingerLink*, 12880-12889.

ENERGIA. (2019). *Gender in the transition to sustainable energy for all: from evidence to inclusive policies.*

Fagbenle, O. (2001). National renewable energy policy objectives and programmes in Botswana. *Elsevier*, 419-437.

FAO. (2020). *Kenya at a glance: The agriculture sector*. Retrieved from Food and Agriculture Orgainziation of United Nation: http://www.fao.org/kenya/fao-in-kenya/kenya-at-a-glance/en/#:~:text=Agriculture%20is%20key%20to%20Kenya's,cent%20of%20Kenya's%20rural%20people.

farming#:~:text=These%20are%20the%20first%20credits,%2C%20sustainable%20and%20climate%2Dfriendly.

Forest, M. o. (2016). *The Forest Management and Conservation Act.* Nairobi: Government Printers and Publishers.

Fraune, C. (2020). Energy Democracy and Participation in Energy Transitions. *Springer Nature*.

Future Watch Report. (2017). *Energy Sector insights- Kenya.* Finland team.

Gallagher, J. E., & Morison, S. (2019). Women in academic leadership: A chance to shape the future. *Elsevier*, 45-48.

GDC. (2020). *Geothermal Development Company*. Retrieved from https://www.gdc.co.ke/menengai.php

Gea, Y., & Zhi, Q. (2015). Literature Review: The Green Economy, Clean Energy Policy and Employment. *Elsevier*, 257-264.

Hamane, T. (2016). *A snapshot of Morocco's Power Sector.* Africa Energy Year Book.

Health Effects Institute. (2019). *State of Global Air 2019. Special Report.* Bostopn: Health Effects Institute.

Herbling, D. (2020, August 4). *Kenya on Course for $5 Billion Nuclear Plant to Power Industry.* Retrieved from Bloomberg: https://www.bloomberg.com/news/articles/2020-08-04/kenya-on-course-for-5-billion-nuclear-plant-to-power-industry

Ibrahim, A. (2011). Renewable energy sources in Egyptian electricity market: Areview. *Elsevier*, 216-230.

IRENA. (2018). *Energy Transition*. Retrieved from nternational Renewable Energy Agency: https://www.irena.org/energytransition

IRENA. (2019). *Morocco- Resource International Renewable Energy Agency*. Retrieved from International Renewable Energy Agency: http://resourceirena.irena.org/gateway/countrySearch/?countryCode=MAR

IUCN. (2013, March 5). *Energy: A gender issue* . Retrieved from International Union for Conservation of Nature: https://www.iucn.org/content/energy-gender-issue

Jalal, I. (2014). *Women, Water,and Leadership.* Asian Development Bank.

Jerneck, A. (2018). What about Gender in Climate change? Twelve Feminist lessons from development. *MDPI*.

Joab-Peterside, S., Porter, D., & Watts, M. (2012). *Rethinking Conflict in the Niger Delta: Understanding Conflict Dynamics, Justice and Security.* Berkeley: University of California.

Johnson, O., & Ogeya, M. (2018). *Risky business: developing geothermal power in Kenya.* Stockholm Environment Institute.

Joy Clancy, U. R. (n.d.). Gender and energy: is there a Northern perspective?

Katikiro, R. E. (2016). Prospect for the uptake of Renewble Energy Technologies in Rural Tanzania. *Elsevier*, 229-233.

KIPPRA. (2010). *A comprehensive study and analysis on energy consumption patterns in kenya.* nairobi.

KNBS. (2019). *Economic Survey 2019.* Kenay National Bureau of Statistics.

Kwame, V. (2020, July 2). *An Inside Look at Kenya's Thermal Power Plants*. Retrieved from Africa sustainability: https://africasustainabilitymatters.com/an-inside-look-at-kenyas-thermal-power-plants/

lambrou, Y., & Piana, G. (2006). *Energy and Gender: in rural sustainable development.* Rome: FAO, publishing Management Service.

Larasatie, P., Barnett, T., & Hansen, E. (2020). The "Catch-22" of Representation ofWomen in the Forest Sector: The Perspective of Student Leaders in Top Global Forestry Universities. *MDPI*.

Laws of Kenya. (2012). *Geothermal Resources Act.* Nairobi: National Council for Law.

Lennon, B., Dunphy, N. P., & Sanvicente, E. (2019). Community acceptability and the energy transition: a citizens' perspective. *Springer Cooperation*.

Louafi, C. (2016). The Energy demand pattern of Algeia, Review of evolution and sustainable development. *International Jouranl Business Adminsitration and Managemnt research*.

Lowitzsch, J. (2019). Introduction: The Challenge of Achieving the Energy Transition. *Springer*.

Mayring, P. (2000). *Qualitative Social Research.*

Mcleod, E., Arora-Jonsson, S., & Masuda, Y. J. (2018). Raising the voices of Pacific Island women to inform climate adaptation. *Elsevier*, 178-185.

Mihayo, I. Z., & Swai, R. M. (2019). Green economy in Tanzania: Is it foreseeable? *Journal of Applied and Advanced Research*, 112-118.

Mihayo, I. Z., & Swai, R. M. (2019). Green economy in Tanzania: Is it foreseeable? *Journal of Applied and Advanced Research,*, 112-118.

Ministry of Energy. (2006). *Energy Act.* Nairobi: Government of Kenya Publishers.

Ministry of Energy. (2018). *Kenya Electricity Sector: Investment Prospectus 2018-2022.* Government printers.

Ministry of Energy. (2018). *Kenya National Electrification Strategy.* Nairobi.

Ministry of Energy. (2018). *National Energy Policy.* MoE.

Ministry of Environment and Natural resources. (2016). *Green Economy Strategy and Implementation Plan 2016 – 2030.* Government Printers.

Ministry of Environment. (2012). *Environmental Management and Co-ordination Act.* Nairobi: National Council for Law Reporting.

Ministry of Environment. (2016). *National Policy on Climate Finance.* Nairobi: The Government Printers.

Ministry of Environment. (2016). *The Climate Change Act.* Nairobi: The Government printer.

Ministry of of Environment, Water and Natural Resources. (2014). *EMCA ( Air Quality).* Nairobi: Government Printer.

Moonga, M. S., & Chileshe, B. (2019). Zambia's Transition to a Green Economy. *ResearchGate*.

Morrison, T. (2014). Women Wall Street and Mitigating Climate Change.

Musango, J., Brent, A. C., & Bassi, A. M. (2014). *Modelling the Transition towards a Green Economy in South Africa.* Elsevier.

Muthama, J. N. (2019). Sub-National policy Readiness as Regards the Planet's Carrying Capacity and Environmental Sustainability in Kenya. *Journal of Sustainability, Environment and Peace*, 6-11.

Muthama, J., Kaume, M., Mutai, K., & Nganga, a. (2015). Simulation of potential impact of air pollution from the proposed coal mining sites in Mui Basin, Kitui County. *Africa Journal of Physical Sciences*, 60-72.

Mutua, P. (2018, May 24). *Coal Mining In Mui To Start As Politics Ebbs Off.* Retrieved November 6, 2018, from https://www.standardmedia.co.ke/business/article/2001281538/coal-mining-in-mui-to-start-as-politics-ebbs-off

Ngoc, H. T., & Anh, a. N. (2016). *Green Economy Development in Vietnam and the Involvement of Enterprises.* Scientific Research. doi: 10.4236/lce.2016.71004

Ngugi, P. (2012). *What does geothermal cost?- the Kenya experience.* Nairobi.

Nhamo, G. (2014). Reviewing Some Implications of the Green Economy for Higher and Further Education Institutions. *African*

*Journal online: Southern African Journal of Environmental Education*.

NNPC. (2019, November 29). *History of the Nigerian Petroleum Industry*. Retrieved from Nigerian National Petroleum Corporation: https://www.nnpcgroup.com/NNPC-Business/Business-Information/Pages/Industry-History.aspx

Nwogwugwu, N. (2019). Women, Climate Change, and Sustainable Development in Africa. *Springer*.

Nyasimi, M., Ayanlade, A., C. M., Derkyi, M., & Jegede, M. O. (2018). Inclusion of Gender in Africa's Climate Change Policies and Strategies. *Springer International Publishing*.

Obi, C. (2009). *Nigeria's Niger Delta: Understanding the Complex Drivers of Violent Oil-related Conflict.* Africa Development.

Ochanda, O. O. (2014). Environmental Impact Assessment in Kenya: Challanges of Emerging Technologies On Development Projects. *Proceedings of Sustainable Research and Innovation Conference, . 5*. Nairobi: Public Knowledge Project.

Ofetotse, L., & Essah, E. (2012). *Energy overview of Botswana: Generation and consumption.*

Okutoyi, P. (2020, May 1). *Logging bans fuels Kenya's forest cover growth.* Retrieved from Africa Sustainability Matters: https://africasustainabilitymatters.com/logging-ban-fuels-kenyas-forest-cover-growth/

Omofonmwan, S. I., & Odia, L. O. (2009). Oil Exploitation and Conflict in the Niger-Delta. *Journal of Human Ecology*, 25-30.

Omotola, S. (2006). *The Next Gulf?: Oil Politics, Environmental Apocalypse and Rising Tension in the Niger Delta.* Durban, South Africa: The African Centre for the Constructive.

ONDUKU, A. (2008). environmental conflicts - the case of the niger delta.

Onwong'a, Y. (2018, November 7). *Kitui county develops it Energy Masterplan*. Retrieved from Kenya News Agency: ttps://www.kenyanews.go.ke/kitui-county-develops-its-energy-masterplan/

Otieno, D. (2018, April 14). *Economic and Environmental Realities Spur Countries Across The World To Close Coal Power Plants.* Retrieved November 6, 2018, from Daily Nation: https://www.nation.co.ke/newsplex/coal/2718262-4393716-sk6otv/index.html

Pan, X., Teng, F., Wnag, X., & Wang, G. (2014). Energy transition within a carbon constrianed world: How allocation schemes influence the development of energy system in future. *Elsevier*, 1310-1313.

REA. (2020, April 9). *The 50 MW Garissa Solar Power Plant.* Retrieved from Rural Electrification & Renewable Energy Corporation: https://www.rerec.co.ke/index.php?option=com_content&view=article&id=53&Itemid=234

Rosen, J. (2018, November 7). *Geothermal Energy Kenya*. (National Geographic) Retrieved November 22, 2019, from https://www.nationalgeographic.com/environment/2018/10/geothermal-energy-kenya-photography/

Saliah, H., Hocne, B., & Toudert, A. (2018). An Algerian Energy policy: Perspective barries missed barriers and oppertunitites.

Saliu, H. A., Luqman, S., & Abdullahi, A. A. (2007). environmental degradation, rising poverty and conflict: towards an explanation of the niger-delta crisis . *journal of Sustainable Development in Africa.*

Say, K., & Rosano, M. (2019). A simulation framework for the dynamic assessment of energy policy impacts on customer PV-battery adoption and associated energy market impacts. *Elesevier*, 3445-3451.

SEI. (2002). *Integrated Energy-Environment Modeling and LEAP.* SEI- Boston and Tellus Institute.

Sekreter, A. (2017). Green Energy for Green Economy: The Case study of Kurdistan Region of Iraq (KRI). *International Journal of Social Sciences & Educational Studies*.

Sekreter, A. (2017). Green Energy for Green Economy: The Case Study of Kurdistan Region of Iraq (KRI). *International Journal of Social Sciences & Educational Studies*.

Shahbaz, M., Loganathan, N., Zeshan, M., & Zaman, K. (2020). Does renewable energy

consumption add in economic growth? An application of auto-regressive distributed lag model in Pakistan. *Elsevier Ltd*, 576-585.

Sida. (2017). *Green Economy= Why, What and How? Stockholm.* Swedish International Development Cooperation Agency.

Simpson, P., & Ashworth, P. (2009). ZeroGen new generation power – a framework for engaging. *Elsevier Ltd*, 4697-4705.

Söderholm, P. (2019). The green economy transition: the challenges of technological change for sustainability. *Springer*.

Susser, D., & Kannen, A. (2017). 'Renewables? Yes, please!': perceptions and assessment of community transition induced by renewable-energy projects in North Frisia. *Springer* .

T.Kousksou, Allouhi, A., Belattar, M., Jamil, A., & Rhafiki, T. E. (2015). Renewable enenrgy

Timilsina, G., & Landis, F. (2014). Economics of transiting to Renewable Energy in Morocco: A general Equilibrium Analysis. *World Bank elibrary*.

Trading Economics. (2020). *Kenya- forest area*. Retrieved from Trading Economics: https://tradingeconomics.com/kenya/forest-area-percent-of-land-area-wb-data.html

UNDP. (2009). *Empowering Agriculture: Energy options for Horticulture.*

UNFCCC. (2015). *Kenya's Intended Nationally Determined Contribution (INDC).* Nairobi: UNFCCC.

UNFCCC. (2019). *What is the connection and why is Gender and Climate Chnage important?* Retrieved from UNFCC: https://unfccc.int/gender

United Nation Environment Programme. (2019). *Sustainability of sugarcane bagasse briquttes and charcoal value chains in Kenya.*

Wai, M. (2016). *Renewable solar and wind power development in Algeria and Morocco.* Energy Studies Institute National University of Singapore.

Williams, M. (2017). *Climate Finance: Why Does It Matter for Women?*

Wolf, S., Jaeger, C., Mielke, J., & Rosen, R. (2017). *Framing 1.5°C - Turning an investment challenge into a green growth opportunity.* Global Climate Forum.

potential and national policy directions fro sustainable development in Morocco. *Elsevier*, 46-47.

Taibi, E. (2018). *Power System Flexibility for Energy Transition, Part 1: Overview for Policy Makers.*

Thairu, N. (2020, April 22). *Kenya Leaps to Top 7 Geothermal Power Producers Globally*. Retrieved from The Kenya Wall Street: https://kenyanwallstreet.com/kenya-leaps-to-top-7-geothermal-power-producers-globally/

The World Bank. (2014, January 2014). *Kenyans Earn First Ever Carbon Credits From Sustainable Farming.* Retrieved from The World Bank: https://www.worldbank.org/en/news/press-release/2014/01/21/kenyans-earn-first-ever-carbon-credits-from-sustainable-

Zhour, A., & Malek, B. (2018). Study of managment startegy of energy resources in Algeria. *Elsevier*.

Zoboli, S. S. (2017). *The Green Economy in Europe: In Search for a Successful Transition.* Springer International Publishing Switzerland.