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Chapter

Toward Sustainable Implementation of Geothermal Energy Projects; the Case of Olkaria IV Project in Kenya

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Abstract

In this chapter, we demonstrate how geothermal has the potential to solve climate change. Geothermal is part of green energy, which contributes toward the achievement of sustainable development goals, that is, SGD 7, on affordable, reliable, sustainable, and modern energy for all, SDG 13, on climate actions, and the Paris Agreement. We present the potential of geothermal energy in Kenya and link it to its ability to provide solutions for Africa and Kenya considering current geopolitics, including Brexit, climate change, the Russian-Ukraine war, and COVID-19. However, this chapter argues that geothermal energy production should be developed within a sustainability framework. Environmental conflicts occasioned by the implementation of developmental projects are on the rise. Geothermal projects are likely to introduce new conflicts between the government and the communities. Therefore, natural resource conflict resolution should be part of the development of geothermal energy. This chapter draws inspiration from a study on conflict types and their management in the Olkaria IV geothermal development project in Kenya. From the study, it is apparent that mediation is one of the sustainable environmental conflict management strategies. The chapter concludes that geothermal energy production has the potential to contribute to the prosperity of Kenya economically.

Keywords: conflict management, geothermal energy development, involuntary resettlement, project affected persons, sustainability

1. Introduction

Geothermal energy is increasingly being taunted as one of the essential resources in fighting the worrisome climate change worldwide. Increased calls for a need to expedite addressing climate change continue to dominate the headlines in different forums globally, including in the United Nations Climate Change Conference (COP26) held in 2021 in Glasgow, United Kingdom. During the COP26 conference, 34 countries and 5 public finance institutions pledged to redirect their public support from fossil fuels to renewable energy.

Notably, concerted efforts have been made worldwide toward investment in the exploitation of renewable energy, including geothermal, to reduce carbon footprints. The development of the geothermal industry enables the availability of one of the most reliable renewable energies that are naturally extracted from the earth's crust. Globally, installed geothermal energy production hit 15,608-megawatt electric (MW) by 2021 [1], with the top three countries, including the United States contributing over 3714 MW, Indonesia about 2233 MW, and the Philippines contributing 1918 MW [1]. Regionally, the Great East African Rift is among the most important world regions harboring a significant geothermal potential of more than 15,000 MW [2], with about 67% of this potential being in Kenya [1, 3].

Kenya tops the African nations in terms of geothermal power generation and is one of the fastest-growing geothermal power producers in the world. The installation of the Olkaria V geothermal power plant (172 MW) in November 2019 pushed the country's geothermal production capacity up to 865 MW with more than 35% of the households in Kenya depending on geothermal power [4]. Currently, Kenya has overtaken Iceland (755 MW), to rank eighth worldwide [1, 5]. The country is nearing the ranks of the United States, Indonesia, Philippines, Turkey, and New Zealand, which are in club 1GW following the commissioning of Olkaria I unit 6 with an installed capacity of 83 MW, which pushes the total geothermal power generation to 944 MW as at 2022.

Geothermal energy development is playing a fundamental role in the energy market in Kenya, contributing about 50% of total generated electricity in 2020/2021 [3, 4]. This is followed by hydro at 39% and thermal at 15%, a drop from 32% in the first half of 2021, while a mere 0.4% is derived from wind power [1].

The exploration of geothermal energy in Kenya seeks to enable the transition of the country into a newly industrialized, middle-income state by 2030, and provide a high quality of life to all its citizens in a clean and secure environment [6]. Geothermal exploitation validates Kenya's global commitment toward inter alia, the Sustainable Development Goals (SDG), that is, SDG 7 on affordable, reliable, sustainable, modern energy for all, and SDG 13 on climate actions [6] as well as the Paris Agreement. SDGs 7 and 13 are vital to the realization of other SDGs. These include SDG 1, on ending poverty in all forms, SDG 2, on eliminating hunger as well as SDG 3, on improving health and wellbeing [7] among others.

The energy sector in Kenya is one of the crucial forces behind its economy, which is key in the manufacturing and agriculture sectors. These sectors are a key backbone to the country's economic growth. Yet, the energy industry is hit hard by a myriad of global and local challenges, including climate change, global pandemics, and social and political instabilities, such as the Russian-Ukraine war and community opposition among others, resulting in energy scarcity with increased prices. Higher oil prices, for instance, escalates production costs, which are subsequently borne by consumers, further resulting in increased cost of living and continued reliance on biomass energy and fossil fuels.

However, a global energy crisis exacerbated by global issues is a blessing in disguise. They present an opportunity for countries, such as Kenya, to pursue and intensify investments in the locally available renewable energy, such as geothermal, wind, solar, tidal, wave, and hydro energy, which remain largely untapped, with only about 9% of geothermal energy exploited from its potential of 10,000 MW [3, 4], as at 2022. Locally, adequate public participation in the design and implementation of energy projects is important in navigating community opposition menace for the sustainability of the projects. As a result, Kenya would be better placed to accelerate

the harnessing of renewable energy resources and cut down on its reliance on energy importation and related costs. These resources would be injected into more impactful public costs and address other socio-economic challenges in the country.

2. Development of geothermal energy

Geothermal can be explained as the heat from the earth's crust estimated to be about 5500°C at the core of the earth, which is as hot as the sun's surface [8]. This energy is manifested on the surface of the earth in form of hot springs, fumaroles and hot-altered sites. Geothermal is the only renewable energy source created naturally by the earth. Geothermal energy is harnessed from underground reservoirs, consisting of hot water and steam, which are naturally replenished, making it both renewable and sustainable.

Deep wells, that is about two kilometers, are drilled to access hot water and steam from the underground reservoirs, and piped up to a well, where it is used to drive turbines connected to electric generators. This creates power for various uses in industries and homes, such as lighting and heating up buildings. In Kenya, geothermal energy is also used for direct utilization at the geothermal fields, including Olkaria, Menengai, and Eburru. These uses include fish farming, recreational purposes, pasteurization of milk, drying of crop harvests, and heating and fumigation of greenhouses [1, 9, 10].

Geothermal energy is a clean, renewable resource that can be tapped globally by countries, such as Kenya, which are located in geologically favorable areas. Geothermal energy is deemed a renewable resource due to the exploitation of the heat from the interior of the earth, which is considered abundant. The used hot water and steam can be cooled and channeled back to the reservoir.

2.1 Advantages of geothermal energy

Geothermal energy advantages over other sources of power, such as wind, solar, and hydro, include:

2.1.1 Stability

Geothermal energy is not affected by the disruption caused by unfavorable weather conditions, such as droughts. It has the highest availability, which is estimated at over 90%, especially in Kenya [11, 12]. Thus, more reliable and secure, and a more suitable source for baseload electricity generation in the country [13, 14].

2.1.2 Eco-friendly

Geothermal is green energy with minimal adverse effects on the environment. Geothermal fields have a low carbon footprint since the energy is extracted from the earth without burning fossil fuels. The pollution associated with geothermal energy is relatively minimal compared to other fossil fuels, such as coal, natural gas, and crude oil.

2.1.3 Vast potential

Increased investment and research toward the exploitation of geothermal resources, with accelerated new technologies, enabling the use of untapped reservoirs. This has contributed to the accessibility, efficiency, and application of

geothermal energy to a wider range of uses. Currently, the advancement in the geothermal energy extracting process, with new technologies, enabling the extraction of geothermal energy from deeper reservoirs.

2.1.4 Small land footprint

Geothermal energy is extracted from the earth's crust, thus can be established on small pieces of land compared to solar, wind, and hydropower energy, which requires large parcels of land. The national geographic estimates that about 400 square miles of the land surface would be adequate to establish a geothermal power plant capable of producing 1 GW-hour of electricity, while a solar and wind farm at the same energy output would need about 2340 and 1335 square miles, respectively.

2.2 Disadvantages of geothermal energy

2.2.1 Restricted location

The installation of geothermal energy plants is restricted to specific locations. Most large geothermal plants require geothermal reservoirs above 100°C, which can only be found near tectonic plate boundaries or hot spots [15], such as the East African Rift System, characterized by the presence of quaternary volcanic centers, that are younger than approximately 2.6 million years, along the rift's margin, with younger centers situated in the south and older centers farther north.

2.2.2 Greenhouse gas emissions

The extraction of geothermal energy from the earth's surface leads to the release of greenhouse gases, such as hydrogen sulfide, carbon dioxide, methane, and ammonia. While these gases are also released into the atmosphere naturally, the rate increases near geothermal plants. However, emissions of these gases are significantly lower than those associated with fossil fuels.

2.2.3 Earthquakes risk

Geothermal power plant installations involve drilling deep within the earth to release hot steam and/or water trapped in rock formations. This causes alterations in the structure of the earth and instability underground that can lead to earthquakes on the earth's surface. Geothermal wells collapse has been reported in the 1950s and 1960s in Wairekei, New Zealand [16]. Geothermal power plants have the potential to cause slow land subsidence over time as geothermal reservoirs are depleted. However, the implications of earthquakes are minor since most of the geothermal plants are situated away from communities.

2.2.4 High costs

Exploration of geothermal energy is capital intensive. A 50 MW well drilling could cost about USD 180 million at testing through full scale development [1]. However, upon its full implementation, the well could be operational for up to 40 years, enabling the recouping of the initial costs.

2.2.5 Summary of the merits and demerits of geothermal energy

Table 1 presents an overview of the advantages and disadvantages of geothermal energy.

2.3 Geothermal resources development in Kenya: a history in brief

Geothermal resources in Kenya are found within the rift valley, which forms part of the East Africa Rift System (EARS), with an estimated potential of up to 10,000 MW spread over 14 potential sites. The EARS is connected to the worldwide oceanic rift systems of over 30 million years ago. The rifting events resulted in tectonic shifts and volcanism and geothermal activity are associated with the occurrence of quaternary volcanoes located within the rift's axis.

Kenya's geothermal exploration for power generation began in 1952 led by the then East African Power & Lighting Company Ltd (EAPL), with the support of the United Nations Development Program (UNDP) and other international agencies [17, 18]. The study resulted in the drilling of two wells in the 1950s. Although temperatures of up to 235°C were recorded, the wells were only discharged in 1971 after stimulation.

Later, the Olkaria geothermal area was selected by the studies that were commissioned to evaluate the resources in various sectors of the rift for a thorough evaluation. This led to the drilling of six deeper exploration and appraisal wells in Olkaria, which were successfully completed and proved the existence of a viable geothermal system. Thus, the first geothermal power plant, Olkaria I, with an electric power capacity of 45 MW, was constructed between 1981 and 1985 (**Table 2**).

Currently, the Olkaria geothermal fields, which are second-most productive in the world after the geysers field in the USA, host five power plants [19], including Olkaria I-V commissioned in the years 1981, 2003, 2009, 2014, and 2019, respectively, with plans to construct Olkaria VI and VII [19–21]. The installed geothermal capacity comprises 706.8 MW by Kenya Electricity Generating Company (KenGen), 155 MW by OrPower4, Inc and 3.6 MW by Oserian Development Company Ltd. Further, 45 MW was added to the grid by Orpower4 between 2015 and 2018. 45 Inc. Olkaria geothermal field is currently the main producing site with an installed capacity of 689.7 MW, while Eburru field has an installed capacity of 2.52 MW.

| Merits | Demerits |
|--|---|
| Geothermal energy is stable/reliable. It is not dependent on prevailing weather conditions. | Energy is confined to specific locations where hot water and/or steam can be tapped from the earth's crust. |
| It emits minimal greenhouse gases (GHGs) unlike other fossil fuels, thus environmental friendly. | The drilling of the resource triggers the release of GHGs into the atmosphere contributing to global warming. |
| Abundant renewable energy. New technologies, research, and investment accelerate its exploitation from untapped reservoirs. | Drilling of the geothermal resource causes instability underground with the potential to cause earthquakes. |
| Energy is extracted from within the earth's surface, thus a small land footprint is required vis-à-vis other renewable energy sources, such as solar and wind. | High upfront cost in the exploration of this energy. |

Table 1.
Merits and demerits of geothermal energy.

| Station and licensee | Year commissioned | Installed capacity | Status |
|-------------------------------------|-------------------------|------------------------|---|
| Olkaria I, KenGen | Unit 1 (1981) | 15 MW | Generation and production drilling |
| | Unit 2 (1982) | 15 MW | |
| | Unit 3 (1985) | 15 MW | |
| | Unit 4 (2014) | 70 MW | |
| | Unit 5 (2015) | 70 MW | |
| | Unit 6 (2022) | 83 MW | |
| | | Total = 185 MW | |
| Olkaria II, KenGen | Unit 1 (2003) | 35 MW | Generation and production drilling |
| | Unit 2 (2003) | 35 MW | |
| | Unit 3 (2010) | 35 MW | |
| Olkaria III, Orpower4 | Unit 1 (2000) | 48 MW (total) | Generation and production drilling |
| | Unit 2 (2009) | 36 MW | |
| | Unit 3 (2014) | 26 MW | |
| | Unit 4 (2016) | 29 MW | |
| | | Total = 139 MW | |
| Olkaria IV, KenGen | 2014 | 140 MW | Generation and production drilling |
| Olkaria V, KenGen | 2019 | 2 × 82.7 MW = 165.4 MW | Generation and production drilling |
| Olkaria VI, KenGen | 2022 (expected) | 140 MW | Surface exploration and production drilling |
| Suswa, CYRQ Energy | 2024 (expected) | 2 × 37.5 MW | Surface exploration and production drilling |
| | | 6 × 42.5 MW | |
| | | Total = 330 MW | |
| Eburru, KenGen | Unit 1 (2012) | 2.5 MW | Generation and Pilot generation |
| | Unit 2 (2019, expected) | 22.5 MW | |
| | | Total 25 MW | |
| Akira, AGL ^a | 2022 (expected) | 1 × 70 MW | Exploration and surface studies |
| Oserian, ODCL ^b | 2003 | 2.5 MW | Production under steam sale |
| Longonot, AGIL ^c | 2019 (expected) | 140 MW | Production drilling |
| Bogoria-Silali, GDC ^d | 2021 (expected) | 200 MW | Production drilling |
| Menengai, GDC | 2020 (expected) | 3 × 35 MW | Production and exploration drilling |
| | | Total = 105 MW | |

^aAkiira Geothermal Limited.

^bOserian Development Company Limited.

^cAfrican Geothermal International Limited.

^dGeothermal Development Company.

Source: Energy & Petroleum Regulation Authority, Kenya.

Table 2.
Geothermal energy fields and status of development in Kenya.

The commissioning of the public-private partnership (PPP), 140 MW power plant, the Olkaria 1 unit 6, 83.3 MW, and 105 MW power plant, which is under development at Menengai geothermal field are expected to increase geothermal power development in Kenya by 328 MW between 2020 and 2022. The Menengai project intends to involve the Geothermal Development Company (GDC) as a steam supplier, while three independent power producers (IPPs) will each install 35 MW. While KenGen continues to appraise and develop several sectors of the Olkaria field, the GDC has further mobilized a drilling rig for exploration drilling in the Paka prospect, and also intends to drill exploratory wells in Silali, Korosi, and the Greater Menengai field within the next few years.

Thirteen IPPs have since been licensed by the government of Kenya to undertake greenfield (areas that have not been previously been developed) projects at Barrier, Longonot, Akiira, Elementaita, Homa Hills, Menengai North, Lake Magadi, Arus, Baringo, Emuruangogolak, Namarunu, and Emuruapoli prospects. These efforts demonstrate Kenya's quest to increase the country's geothermal output to 5000 MW from the current 944 MW by 2030 [1].

2.4 Barriers to geothermal development in Kenya

The East African Rift System has significant potential for clean energy exploitation for the countries in East Africa, Kenya included. Yet, over 95% of the geothermal energy resources remain unexploited. Similarly, to other African states, Kenya is facing a number of challenges in maximizing the harnessing of geothermal resources. These issues included.

2.4.1 High exploitation and infrastructure costs

Whereas, steam or hot water is readily available for constant supplies at Olkaria geothermal field, the likely delays in exploitation experienced elsewhere in the rift valley by private companies in Longonot and Akiira demonstrate the difficulty in finding investors who would be patient to finance additional exploration. A single exploration well where no previous development has been done costs over USD 1 million to drill, with three wells needed to prove resource availability [22]. It is also estimated that a 20 MW geothermal power plant could cost about USD 80 million, which could be unaffordable in the event of a reduced number of customers with declined demand.

2.4.2 Political instability and community opposition

Political instability and community opposition are major deterrence to development and investment in geothermal resources, especially for IPPs. The geothermal development in Olkaria IV, for instance, faced community resistance following its relocation in 2014 amidst claims of unfair compensations, which almost derailed its implementation. However, the application of mediation as a conflict resolution strategy, in this case, helped to reduce conflicts between the developer and the project affected persons (PAPs), mended relationships, improved community livelihoods, and allowed smoother operations of the project.

2.4.3 National and county levels bureaucracy

The control at the national levels is often deemed as a threat to the county governments, which fail to adequately manage their own issues including ensuring

that “*Wanjiku*,” that is, the local communities at the county levels are well represented [22] in all matters of development including energy projects. Also, added bureaucracies at the national levels are seen as fertile ground for political interferences and a threat to approvals for important projects, such as geothermal energy. The bureaucracies at the county levels, with possible inadequate participation of the private developers in the management of local affairs, are considered as a possible avenue for corruption, which could adversely impact important development.

2.5 Opportunities for the development of the geothermal industry in Kenya

2.5.1 Prevailing global issues

The escalation in energy prices emanates from the weakening of economies already battered by the impacts of the coronavirus pandemic worldwide, such as lockdowns and disturbances, to global supply chains worsened by increased fuel prices. The Russian-Ukraine war has heightened the energy crisis, further resulting in uncertainty in global oil and gas markets with soaring energy prices.

In Kenya, this impact has been felt by its citizens who have had to dig deep into their pockets to meet the cost of basic necessities. For example, before the onset of the Russian-Ukraine, a 6 kg cooking gas cylinder retailed at about USD 7. This shot up to about USD 13 during the Russian-Ukraine war era. However, these global disturbances present an opportunity for countries to accelerate the transition to alternative sources of energy, including geothermal energy. This is particularly in countries, such as Kenya, which has the potential of up to 10,000 MW, yet only about 9.4% has been tapped as of 2022.

Further, the ravaging impacts of droughts with declined hydropower generation, compounded with a decline in fossil fuels, such as coal, oil, and natural gas, provides an opportunity for countries, such as Kenya, to intensify investments toward the exploitation of the untapped geothermal reservoirs.

2.5.2 Resource availability

Kenya is endowed with abundant geothermal resources, which are estimated at about 10,000 MW. These resources are found along the world-famous East African Rift Valley, which transects from the north to the south of the country. The resources are spread over 14 sites, with Olkaria, Menengai, and Eburru being the most developed geothermal sites. Suswa, Longonot, Arus-Bogoria, Lake Baringo, Korosi, Paka, Lake Magadi, Badlands, Silali, Emuruaogolak, Namarunu, and Barrier are other potential sites currently under exploration. Only 944 MW has been harnessed as of 2022, enabling the country to rank eighth globally in terms of geothermal energy production.

2.5.3 Legal and institutional framework

The Energy Act, 2019, which repealed the Energy Act, 2006, the Kenya Nuclear Electricity Board Order No. 131 of 2012, and the Geothermal Resources Act, 1982 promotes renewable energy and promotes exploration, recovery, and commercial utilization of geothermal energy among others, creating an enabling environment for accelerated development of geothermal resources in the country.

Over two decades ago, the development of geothermal resources was solely tasked to Kenya Power and Lighting Company (KPLC), a state-owned electricity generation and distribution company, under the Ministry of Energy, which derailed its development. Subsequent reforms within the energy sector attracted wider energy developers. For example, the policy on new feed-in-tariffs (FIT) that was introduced in 2008 in line with the Energy Act, 2006, then provided for investment security to renewable electricity generators, reduce administrative and transaction costs attracting many IPPs, who currently include ORMAT, Akiira Geothermal Company Ltd, and Quantum East Africa Power Ltd among others into geothermal development for electricity and direct utilization in the country [17].

The Kenya Vision 2030 launched in 2008 emphasizes the exploitation of renewable energy to reduce reliance on imported fossil fuels and increase access to electricity. With this economic blueprint, the country aims to achieve a geothermal production capacity of up to 5000 MW by 2030.

2.5.4 Technical expertise

Unlike other east African countries, Kenya, currently ranked 8th worldwide in terms of geothermal energy production, has a robust, skilled, local geothermal workforce, and technical capacity. This is boosted by the establishment of the African Geothermal Training Center (AGCE) in the country. This facility was established in June 2018 by the African Union Commission and UN Environment (UNEP). However, there is still a need for support from foreign experts to maximize harnessing of the geothermal resources.

2.6 Analytical/theoretical framework

2.6.1 Sustainable practices in energy development

Sustainability Development involves a progressive transformation of economy and society. A development path that is sustainable in a physical sense could theoretically be pursued even in a rigid social and political setting. But physical sustainability cannot be secured unless development policies pay attention to such considerations as changes in access to resources and in the distribution of costs and benefits. Even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation (Our common future, UN).

The term sustainability is simply the capacity to endure when applied broadly it can be defined as “meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.” Sustainable development can be defined as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainability may be viewed as a three-legged table consisting of the environment, the economy and society, or as a dualistic relationship between human beings and the ecosystem they inhabit.

2.6.2 Environmental sustainability

This is a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs, while neither exceeding the capacity of its

supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity. Renewable energy production systems are largely seen to fulfill the environmental sustainability condition.

2.6.3 Economic sustainability

It involves creating economic value out of whatever project or decision you are undertaking. Economic sustainability means that decisions are made in the most equitable and fiscally sound way possible while considering the other aspects of sustainability. From an economic standpoint, sustainability requires that current economic activity not disproportionately burdens future generations. Economists will allocate environmental assets as only part of the value of natural and manmade capital, and their preservation becomes a function of overall financial analysis.

Economic sustainability should involve analysis to minimize the social costs of meeting standards for protecting environmental assets but not for determining what those standards should be. Components of the economic environment include residents and households, public infrastructure, community facilities and the natural environment (essential services, such as water and sanitation systems, electricity, gas, telecommunications, and transport), business enterprises and supply networks (retailers, distributors, transporters, storage facilities and suppliers that participate in the production and delivery of a particular product), not-for-profit sector, and government. Comparing geothermal energy to fossil fuels, the former is seen to be more economically sustainable considering the ongoing global challenges, such as the Russian-Ukraine crisis and instability in Gulf states.

2.6.4 Social sustainability

This is based on the concept that a decision or project promotes the betterment of society. Further, future generations should have the same or greater quality of life benefits as the current generation do. This concept also encompasses aspects of human rights, environmental law, and public involvement and participation. Energy production systems whether renewable or nonrenewable are socially sustainable if they fulfill the following aspects [23]:

- a. Equity of access to key services.
- b. Equity between generations.
- c. A system of relations valuing disparate cultures.
- d. Political participation of citizens, particularly at a local level.
- e. A sense of community ownership.
- f. A system for transmitting awareness of social sustainability.
- g. Mechanisms for a community to fulfill its own needs where possible.
- h. Political advocacy to meet needs that cannot be met by community action.

Environmental conflicts are generally viewed as an outcome of production systems that fail to fulfill the condition of social sustainability. The Global Environmental Justice Atlas (EJAtlas) [24], linked slightly more than 2520 socio-environmental conflicts to large projects and communities worldwide. More than 345 of these conflicts are related to the construction of renewable energy amenities, climate fixes, and dams. In Kenya, in the northern-western, Turkana County, the oil and wind projects generated conflicts between the host communities and operating companies. The communities were displeased with the unfulfilled pledges concerning land compensation, improved water supply, and employment prospects [25–28]. These concerns were exacerbated by communication break down between Tullow and the residents [26, 29]. This led to continued disruption of the company's operations [27]. Also, the fencing of all sites, including for extraction and oil storage, was fenced, restricted communities' access, and dislocated pastoral migration routes, resulting in conflicts between the developers and these communities.

The community was discontent with the benefit-sharing arrangement and accused the national government of lack of transparency in awarding the tender to Fenxi company in 2011 derailing its implementation, in the case of the Mui Basin coal exploration project located in Kitui, Kenya [30, 31]. The community was still contesting the project by the time [31] were conducting their research on public participation in Africa's mining sector.

The proposed 1050 MW Lamu coal power plant project, which was expected to be operational in 2020, had been projected to be the largest in east Africa and the first in Kenya. However, the project failed to start off in October 2015 as planned [32, 33] following the Civil Society Organization Save Lamu's and the community's opposition. These groups were anxious over unavoidable environmental and health impacts, such as pollution of fishing grounds, that would have seen hundreds of fishermen lose jobs and premature deaths linked to air pollution. The continued protests compelled the project donor, the Industrial and Commercial Bank of China (ICBC), to withdraw its financial support due to looming environmental and social hazards.

3. Conflicts and development of renewable energy in Kenya: case study of Olkaria IV geothermal energy project

This section is based on a study by [21, 34] on conflict types and management in the development of geothermal energy in Olkaria IV area. The Olkaria IV geothermal project is located in the Olkaria geothermal block in Naivasha-Sub-County, Nakuru County, Kenya, partially within the Hell's Gate National Park (HGNP). Olkaria area is inhabited by about 20,000 pastoralists, whose main livelihood stream is supported by pastoralism and livestock trading, with a number of community members relying on tourism activities (**Figure 1**) [21, 36].

Olkaria IV geothermal power plant has an installed capacity of 140 MW. The plant was established by KenGen. It was supported financially by the Government of Kenya (22%), the European Investment Bank (EIB, 12%), the Japan International Cooperation Agency (JICA, 23%), the French Development Agency (AFD, 15%), the German Development Agency (KfW, 7%), the World Bank (7%) with KenGen injecting 14% [36, 37].

Olkaria IV geothermal power plant was established as part of the Kenya Electricity Expansion Project (KEEP) to deliver on Vision 2030 of seeing Kenya transition into a newly industrialized, middle-income state, and provide a high quality of life to all

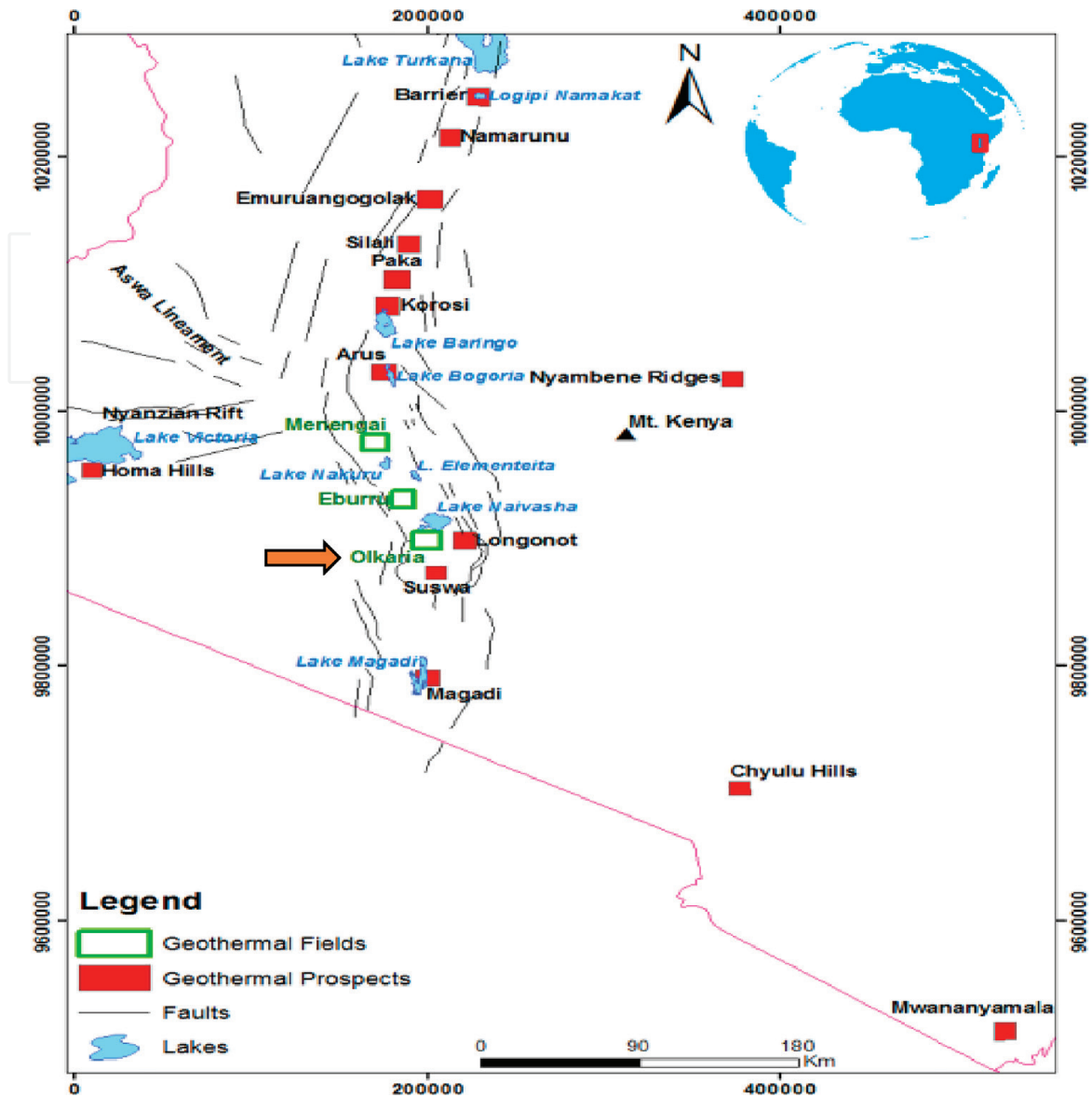


Figure 1. Location of Olkaria geothermal field/study area. Source: [35].

its citizens in a clean and secure environment, and SDG 7 on affordable, reliable, sustainable, modern energy for all, and SDG 13 on climate actions [6]. However, its installation was faced with conflicts between KenGen and the project-affected persons (PAPs) that persisted beyond its completion.

An environmental social impact assessment (ESIA) on the project demonstrated that the drilling of the power plant would negatively impact the health of the community. This necessitated the relocation of four villages inhabited by the Maasai community, including Cultural Centre, OlooNongot, OlooSinyat, and OlooMayana Ndogo to a new site, that is, resettlement action plan land (RAPland), which was located outside the park.

However, upon relocation, the community became agitated and raised complaints regarding incomplete projects at RAPland and accused KenGen of failing to deliver on some of the pledges made earlier, as stipulated in the memorandum of understanding signed between KenGen and the PAPs. These conflicts revolved around the socio-economic (51%), cultural (14%), environmental (21%), and political (14%) aspects [21].

Regarding the socio-economic conflict, the PAPs cited increased distance to work at the project site and shopping centers in Kamere and Naivasha, and increased travel costs exacerbated by bad roads and inadequate means of transport. They also pointed out that the water collection and watering points were inadequate and unreliable, with an unreliable electricity supply, while some houses had no electricity. Declined income accrued from selling traditional ornaments and guided tours at the former site was another main cause of disagreement. The respondents suggested that they would have appreciated adequate financial compensation, including USD 5000, as a disturbance allowance to help them settle in the new site.

Environmentally, the respondents complained of poor terrain characterized by poor grazing areas of low-quality pasture. The unwelcoming valleys and gullies posed a danger to community members and their livestock, while the hyenas had become a nuisance, killing PAPs' livestock daily. Also, the respondents were unconvinced of the development's potential adverse effects on their health as earlier informed by KenGen. They claimed that they were never furnished with documented scientific evidence of the latent negative effects of noise pollution, as indicated by the developer.

Cultural issues were mainly linked to the standard two-bedroom houses built at RAPland, which some PAPs claimed failed to provide for the customary needs for exclusive units for the husbands, wives, sons, and daughters. Also, some women were dissatisfied on the basis of their views being disregarded, exacerbated by the patriarchal system, which forbids women from speaking in the same public spaces as men. The community leaders had an obligation to make decisions on behalf of the community. Thus, community members had to abide by a decision made regarding relocation irrespective of their feelings.

Politically, KenGen was accused of improper sharing of information relating to the development of the project. Also, the developer was blamed for the alleged inadequate involvement of PAPs in project meetings and in the decision-making processes involving their compensation and relocation logistics. PAPs felt that KenGen tricked them to relocate, so as to expand geothermal developments by making promises, some of which were never fulfilled, including a USD 5000 disturbance allowance. The majority of the PAPs (77%) would have appreciated more support, including financial compensation and more time to prepare for the relocation.

3.1 Geothermal energy production conflict effects

Conflicts resulted in abandoned businesses at HGNP and reduced tourism activities. This impacted negatively on the livelihoods of members of the Cultural Center

| Approach | Indicator | Project phase |
|---------------|--|--|
| Competition | PAPs were coerced into agreement | Initiation, relocation |
| Avoidance | PAPs involuntarily agreed to relocate | Relocation |
| Collaboration | Attempts were made for KenGen and PAPs to talk and resolve issues through meetings/ <i>barazas</i> | Initiation, relocation, implementation |
| Accommodation | PAPs had no choice but to move to pave the way for the establishment of Olkaria IV for the benefit of the entire nation. | Initiation, relocation |
| Compromise | Mediation and negotiation | Implementation |

Table 3.
Conflict management approaches.

village, who led in these activities. It was also noted that about half of PAPs lost their jobs through punitive measures taken for participating in protests against relocation, while those who resisted relocation lost friends. PAPs that were seen to associate themselves with the resistance group were threatened with legal sanctions and isolation by the developer.

3.2 Geothermal energy production management of conflicts

Traditionally, conflict can be explained as “a struggle over values and claims to scarce status, power and resources in which the aims of the opponents are to neutralize, injure or eliminate their rivals [38, 39].” Generally, conflicts exist wherever or whenever incompatible activities occur, including in developmental projects, and may result in win-lose character. Flagship projects, such as geothermal energy, which bring together diverse stakeholders, including the host community, the state, the project developers, and donors, among others, often attract conflicts following their varying interests. Conflict occurrences can also be heightened by the factors, such as different comprehension of the project plans, resource scarcity, and varying priorities of the stakeholders involved [40, 41].

Unresolved conflicts can have detrimental implications in a development project, including hurting the relationships, between the developer and the community with subsequent delays in project implementation, loss of the project’s social license, increased cost of the project, its rejection, termination, and in worst-case scenario, loss of lives [21, 42–45].

This study documented the various strategies used to manage the conflicts associated with geothermal energy production in Olkaria, Naivasha Sub-county, Nakuru County, and Kenya. The main strategies employed were competition, avoidance, collaboration, compromise, and accommodation (**Table 3**). The different strategies were employed at different stages of the project implementation.

However, competition, avoidance, collaboration, and accommodation as conflict management strategies were deemed ineffective following the persistence of conflicts beyond relocation. The PAPs wrote to the World Bank and the European Investment Bank seeking their intervention, leading to mediation that was recommended by the project donors. This mediation process was fruitful, as indicated by 82% of the interviewees. The PAPs applauded the mediated negotiation of the twenty-seven thorny issues inter alia, the construction of five more houses for those who had been left out, and improved services at RAPland, most of which were agreeably addressed. This has since then led to an improved relationship between KenGen and the community.

4. Conclusion

This chapter has attempted to position geothermal energy production in Kenya as a sustainable development practice. Indeed, Kenya has great potential for green energy based on its strategic geographical location. Kenya’s physical environment provides a great opportunity for green energy, that is, solar and wind energy potential in vast northeastern arid lands, wind, tidal, and waves energy at the coast, and geothermal energy springs in the rift valley. Kenya heavily relies on fossil fuels for its production and transport systems. Most of the imported energy for Kenya comes from the Gulf states. However, with current global geopolitics, such as Brexit, the Russian-Ukraine war, and conflicts in areas, such as Yemen, the supply and prices for

fossil fuels have become very unstable and unpredictable. Consequently, there is an alarming increase in prices of commodities that heavily rely on fossil fuels in their production and transportation lines. This has resulted in economic inflation and the situation has been exacerbated by the recent COVID-19 pandemic, which has slowed economic activities globally. The current situation is threatening to plunge Kenya into an economic crisis with threats of political instability occasioned by unrest by the masses who are not only unable to get employment opportunities but also to put food on their table thanks to high food prices. It should also be noted that the world is moving toward green energy as a way of combating climate change caused by the increase in greenhouse gases emitted into the atmosphere, hence leading to global warming. European countries are already setting targets for going green. Germany, for example, targets to have all cars on its roads electric by 2030. This global developmental shift to green energy is important for African countries, and Kenya in particular. Kenya is a leading geothermal energy producer in Africa and has great unharnessed potential. Kenya can position itself as an exporter of green energy (geothermal, wind and solar, etc.) to the rest of Africa if the right investment decisions are made now. This chapter argues that the right energy development decisions are those that conform to the three pillars of sustainable development, namely, the economy, ecology, and society. Whereas geothermal energy production is arguably one of the most economically and environmentally friendly, there is a need to be sensitive to the needs and aspirations of the communities within which the wells are developed to achieve social sustainability. One of the most sustainable environmental conflict management strategies is mediation as has been demonstrated by ref. [21, 34] in the case of conflict resolution between the government and Maasai communities in the Olkaria IV geothermal field.

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