Promoting Sustainable Energy Development

A Guide to Geothermal development in Uganda

A Civil Society Perspective

A Publication of The National Association of Professional Environmentalists (NAPE)-UGANDA

SIEMENPUU FOUNDATION

This publication has been funded by the Siemenpuu Foundation (Finland)

GEOTHERMAL PROSPECTS IN UGANDA

Figure 1: Location of geothermal areas of Uganda

"Studies have shown that geothermal energy is the least cost power generation option" KENGEN (http://www.kengen.co.ke)

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June 2005

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The publication is on "promoting sustainable energy development; a guide to geothermal development in Uganda." It is a most timely publication, especially in the context of the current debates on poverty reduction, more so in the rural areas where the majority of the poor live. The debate has become particularly serious, as statistics in the country indicate that in several areas poverty is increasing, and even where it appears not to be increasing, there are pockets of extreme poverty.

Hence, any measure that contributes to enhancing quality of life of the people is highly appreciated. The Poverty Eradication Action Plan (PEAP) itself recognises this, when it states that; "energy supply is critical to enhancing production, competitiveness and incomes", and that, "recent survey shows evidence that there are significant returns to rural electrification in reducing poverty". One needs not to go into further details since, most of the readers in the country are aware of what is happening in the rural areas:- effects of charcoal burning, and how lack of rural electrification reduces development opportunities in agriculture, social services and employment.

Civil society in Uganda has an obligation to educate, to inform, to critique and to advise. It also has an obligation to support government in its "pro-people" development strategies and to continuously knock on its door where it appears to slacken in listening to peoples' cries. It is in this context that these guidelines and similar activities are carried out by NAPE and its partners. The publication reflects views and suggestions of the many stakeholders and thus carries commendable mandate and legitimacy. It is hoped that there will be sufficient political will to utilize suggestions contained in this most worthwhile study, so that the rural people and others can also live the good life that they are entitled to.

Finally, one must stress that geothermal is particularly welcome for its obvious characteristics in a country like Uganda, where fuel wood consumption meets about 85% of Uganda's total energy requirements. Geothermal is environmentally friendly and supports sustainable development.

Professor Jassy B. Kwesiga
Executive Secretary-DENIVA

Acknowledgement

The work of The National Association of Professional Environmentalists (NAPE) is founded on the efforts of many individuals and institutions around the country and the world at large who took time to reflect on the state of geothermal and other energy resources and the need to develop and manage them in a sustainable manner.

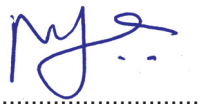
While we cannot name all who have contributed to the development of this geothermal guide, we would like to express our special appreciation to a few: The Swedish Society for Nature Conservation (SSNC) - Sweden, whose generous support made it possible for data collection and compilation from within and outside Uganda, Siemenpuu Foundation - Finland, who had the inspiration to support the publication and launch of the guide, giving it continous support, and Uganda Government through the Ministry of Energy and Mineral Development, and other government departments and institutions; Department of Geological Survey and Mines (GSMD), Uganda WildLife Authority (UWA) and, National Environment Management Authority (NEMA) that provided information and reviewed the various drafts.

We thank all government, non-governmental organizations and individuals that supported our efforts by reviewing the guide document and actively participating in the various consultative stakeholders' meetings, particularly, the Iceland representative in uganda, Stive Hirsh (geothermal consultant), International Rivers Network (IRN), The East African Communities Organizations for the Management of Lake Victoria Resources (ECOVIC), Uganda Wildlife Society (UWS), The Development Network of Indigenous Voluntary Associations (DENIVA), Uganda Coalition for Sustainable Development (UCSD), Greenwatch, Uganda Environment Education Foundation (UEEF), The Albertine Rift Conservation Society (ARCOS) among others.

Finally we express our thanks for the tireless efforts of NAPE Board and staff for coming up with this guide. Special thanks go to: Kamese Geoffrey Nansove, Muramuzi Frank, Oweyegha-Afunaduula F.C, Tabaro Dennis, and Obbo Betty who collected data, compiled and edited this guide.

Once again, our heart-felt thanks go to the many unnamed individuals and institutions who have made the publication of this guide a success.

Signed:



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Muramuzi Frank

Executive Director - NAPE

List of Acronyms

AFREPREN	Afircan Energy Policy Resarch Network
ARCOS	Albertine Rift Conservation Society
BCSE	Business Council for Sustainable Energy
BOO	Build Own Operate
CDC	Commonwealth Development Corporation
CO_2	Carbon Dioxide
COMESA	Common Market for Eastern and Southern African States
CREFM	Convention on the Recognition and Enforcement of Foreign Arbitral Award
CSO	Civil Society Organisation
DENIVA	The Development Network of Indigenous Voluntary Associations
DRC	Democratic Republic of Congo
DWD	Directorate of Water Development
ECOVIC	The East African Communities Organisation for the Management of Lake Victoria Resources
EIS	Environmental Impact Studies
ERT	Energy for Rural Transformation
GATS	General Agreement on Trade in Services
GNESD	Global Network on Energy and Sustainable Development
GOU	Government of Uganda
GSMD	Geological Survey and Mines Department
H_2S	Hydrogen Sulphide
IBRD	International Bank for Reconstruction and Development
ICSID	International Centre for Settlement of Investment Disputes
IEA	International Energy Agency
IFI	International Financial Institutions
IRN	International Rivers Network
KenGen	Kenya Electricity Generating Company Limited
KPLC	Kenya Power and Lighting Company
KWh	Kilo Watt Hour
LPG	Low Pressure Gas
MEMD	Ministry of Energy and Mineral Development
MIGA	Multi-lateral Investment Guarantee Agency
MW	Mega Watt
NAPE	National Association of Professional Environmentalists
NEMA	National Environmental Management Authority
OECD	Organisation for Economic Co-peration and Development
OPIC	Overseas Private Investment Corporation
RET	Renewable Energy Technologies
SSNC	Swedish Society for Nature Conservation
TRIMS	Agreement on Trade-Related Investment Measures
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UCSD	Uganda Coalition for Sustainable Development
UEEF	Uganda Environment Education Foundation
UIA	Uganda Investment Authority
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UWA	Uganda Wildlife Authority

UWS	Uganda Wildlife Society
UTB	Uganda Tourism Board
U.S.	United States
VAT	Value Added Tax

PART 1: BACKGROUND

1.1 Introduction:

Uganda is endowed with a rich geothermal potential mainly located in the rift valley parts of the country. Geothermal development is especially important for providing energy to the rural communities and in ensuring energy security for the whole country. It can play an important role in the conservation of environmental resources, especially forests and other biomass resources that are currently used as a source of energy. Geothermal energy uses little land, is clean, renewable, decreases deforestation, increases energy diversity and provides local jobs for construction, operation and maintenance. If the geothermal resource is developed, government will come near to realising its objective of rural electrification, modernising agriculture and ensuring energy security for all.

In order for government, industry and the general population to realise the benefits from geothermal energy, there is need for the country to strategically plan for its development. To this end, civil society has come up with this **Geothermal Development Guide for Uganda** to complement governments' efforts in this direction.

1.1.1 The Goal of the Guide:

The overall goal of this Guide is to promote sustainable social, economic and environmental development through sound development of the country's rich geothermal potential. This Guide, therefore, attempts to bring out some of the presumed best practices that may help the country attain appropriate social, economic, technical and administrative levels of environmental conditions for the protection of public health and the environment.

1.1.2 Objectives of the Guide:

The following are the main objectives of the Guide:

i. To help the Government of Uganda adopt improved geothermal development methods for lasting benefits
ii. To identify and promote adequately planned and environmentally friendly geothermal development programs that are beneficial to the local communities and the country at large
iii. To promote practices that ensure sustainable utilization of natural resources for national and socio-economic development
iv. To contribute to government programmes and efforts towards providing Energy for Rural Transformation (ERT) so as to reduce rural and national energy poverty
v. To lobby and advocate for further strengthening of institutional capacity to be able to steer and monitor sustainable geothermal development in the country

According to the **Global Network on Energy for Sustainable Development**, *"About 2.8 billion people or close to the half the world population's is estimated to survive on less than US$2.00 per day - the "poor" as defined by international agencies such as the IEA, World Bank, UNDP, UNEP and OECD. A key distinguishing feature of the world's poor is inadequate access to cleaner energy services. The majority of those earning less than US$ 2.00 per day rely on traditional bio-fuels to meet the bulk of their energy needs and have no access to electricity. Traditional bio-fuels meet the bulk of the energy needs of an estimated 2.4 billion people. Some 1.6 billion people have no access to electricity and significant portion have limited or no access to cleaner and more modern fuels such as kerosene, LPG and natural gas".*
http://www.gnesd.org/rationale.htm

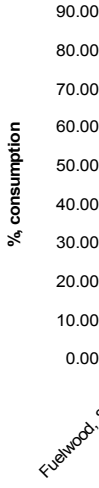
vi To promote geothermal development as a way of poverty alleviation for the rural poor from the current adverse economic and energy poverty

As members of civil society in Uganda, we believe that this Guide will go along way in ensuring the sustainable development and management of geothermal resources in the country. Whereas the guide tries to bring out a number of pertinent issues on geothermal development in the country, it does not underplay other good practices in the energy sector.

1.2 The Energy Status for Uganda

Uganda is one of the poorest countries of the world with a population estimated at 26.8 million people, and growing at a rate of 3.3%. The energy sector in the country is mainly characterised by high consumption of biomass energy with about 97% of households in the country heavily dependant on biomass energy sources, while another 92% of the population do not have access to electricity. Only about 8% of the country's total population has access to electricity and of these only about 2% are located in rural areas. The electricity demand rate has been estimated to be growing at a rate of 8% per annum creating a need for increased power generation. The annual energy consumption in the country has been estimated at 20 million tonnes of wood fuel, 430,000 tonnes of oil products, and an installed hydropower capacity of about 300 MW from two large hydropower dams (Kiira and Nalubaale) on River Nile. The country also has an installed small hydropower capacity of about 13.05 MW and an installed cogeneration capacity of 10MW. An additional thermal generation capacity of more than 53 MW is produced to meet the energy deficit of the country arising from the decline in water level of Lake Victoria. Several companies and individuals also generate thermal electricity that is not accounted for in the national energy balance.

Fig 2. Energy consmption in Uganda 2001



Source: Ministry of Energy and Mineral Development (MEMD)

Since colonial times, Uganda has mostly relied on Nalubaale Dam which has been recently complimented by Kiira Dam. Long transmission lines reach the main urban centres. However, for some time now, the energy demand of a rapidly growing population and industry has outpaced the supply. Conventional energy projects have not only failed to meet the domestic energy needs, but have also contributed to the country's debt burden. Despite heavily investing in conventional energy sources using large sums of borrowed and locally generated

funds, it has been difficult for the country to transmit and market the generated power to many rural parts of the country. Even today when government efforts are focused on rural electrification, there is heavy dependance on external borrowing from major lending institutions such as the World Bank.

The Uganda energy status today does not favour easy access and use of affordable sustainable energy sources. There is inefficient supply and use of renewable energy technologies (RETs). The potential to consume modern energy in many rural parts of the country has remained low mainly because of the high costs associated with these energy services. This has led to wastage of the country's limited financial resources and to heavy, everising tariffs on the few consumers that can access and use these services.

The location of major electricity sources along the River Nile requires large transmission costs that have often frustrated extension of the national grid to many rural parts of the country. Where transmission has been possible, high-energy losses associated with long distances transmission have had negative impacts on efficient use of the little available energy. The prevailing energy poverty in many parts of the countryside has greatly affected their economic growth.

Inadequacies in energy supplies have meant continued subsistence-level economies that are characterized by inefficient use of non-commercial energy, low agricultural productivity and low standards of living. Rural development, therefore, will largely dependent on the country's ability to meet the gradual growth in demand for modern energy services. Renewable energy sources are often the best option for rural areas and their development would greatly facilitate the transformation of rural economies by improving production and income in the agricultural and non-agricultural economic sectors . The need to meet people's basic energy needs can best be achieved through an approach that considers a mixture of both conventional and renewable energy sources in an integrated manner. This approach should consider developing renewable energy resources in the same framework as conventional energy sources. Renewable energy sources can play a complementary role to conventional energy in offsetting the energy supply deficit and bringing modern energy service to areas far from the grid. Government's new approach that considers development of decentralized options and technologies is likely to help in promoting energy for rural transformation and agricultural development. One of the renewable energy resources with such a promising potential is geothermal. Recent efforts to develop the country's geothermal potential raise hope for sustainable rural electrification and energy security. When developed, geothermal is likely to play a vital role in offsetting the energy imbalances in the country and create employment opportunities for the rural population.

Despite the enormous geothermal potential in Uganda, harnessing of this resource potential is yet to be realised. The major reasons that have hindered development of the resource have mainly been the cost of geothermal development in relation to the cost of large hydropower and environmental concerns. Although Government of Uganda has expressed interest in developing this resource, for several years this commitment has not been translated into a reality. Government is currently carrying out detailed studies on selected sites that have shown a great generation potential.

This guide, therefore, has been developed as a proactive approach towards sustainable development of the country's geothermal potential which is one of those energy sources that are rural based. This guide has been developed through a consultative process involving various stakeholders in and outside Uganda.

PART 2: GEOTHERMAL ENERGY

2.1 Sources of Geothermal Energy

Geothermal heat originates from the Earth's inner core of dust and gas that has been accumulating for over 4 billion years. At the earth's core - 4,000 miles deep - temperatures may reach over 4245°C. This heat continuously flows outward from the earth and is transferred to the surrounding rock layer- the **mantle**. When temperatures and pressures become high enough, some mantle rock melts, becoming **magma**. Magma rises slowly up toward the earth's crust, carrying with it heat from underground. At its worst this heat may force hot magma to reach the surface in volcanic eruptions. In instances where the magma remains below the earth's crust, it heats the nearby rocks and water which could sometimes be as hot as 330°C (see fig. 2a-b). As a result of the high pressures developed, some of this hot geothermal water travels up through faults and cracks and reaches the earth's surface as hot springs or geysers although most of it stays deep underground, trapped in cracks and porous rock. This natural collection of hot water is known as a geothermal reservoir.

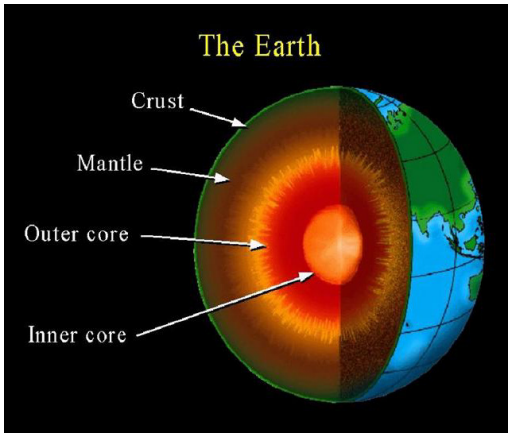


Figure 2a: The Earth Crust
Source: Business Council for Sustainable Energy

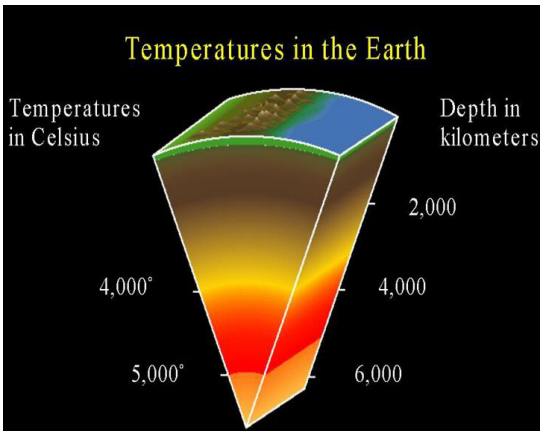


Figure 2b: The Temperatures of the Earth
Source: Business Council for Sustainable Energy

2.2 Characteristics of Geothermal Reservoirs

Geothermal reservoirs have different characteristics, which usually determine the type of geothermal power plant that is to be constructed. There are three kinds of geothermal power plants. The kind of plant that is built usually depends on the temperatures and pressures of a reservoir. These reservoirs are characterised as follows;

- A "dry'" steam reservoir produces steam but very little water. The steam is piped directly into a "dry" steam power plant to provide the force to spin the turbine generator. The largest dry steam field in the world is the Geysers, about 90

miles north of San Francisco. Production of electricity started at the Geysers in 1960 and continues today, at what has become one of the most successful alternative energy projects in history

- Geothermal reservoirs that mostly produce hot water are called hot water reservoirs and are used in a **"flash"** power plants. Water ranging in temperature from 150 - 230°C is brought up to the surface through the production well where, upon being released from the pressure of the deep reservoir, some of the water flashes into steam in a 'separator.' The steam then powers the turbines
- In a binary system the geothermal water is passed through a heat exchanger, where its heat is transferred into a second (binary) liquid, such as isopentane, that boils at a lower temperature than water. When heated, the binary liquid flashes to vapour, which, like steam, expands across and spins the turbine blades. The vapour is then re-condensed to a liquid and is reused repeatedly. In this closed loop cycle, there are no emissions to the air

With technological improvements in geothermal harvesting methods, the amount of power produced by geothermal plants will continue to rise. Usable geothermal resources will no longer be limited to the "shallow" hydrothermal reservoirs at the crusted plate boundaries. Much of the world is underlain by hot dry rock - no water, but lots of heat. Some scientists have experimented with piping water into this deep hot rock to create more hydrothermal resources for use in geothermal power plants. As the drilling technology improves, geothermal energy from hot dry rock could be available anywhere.

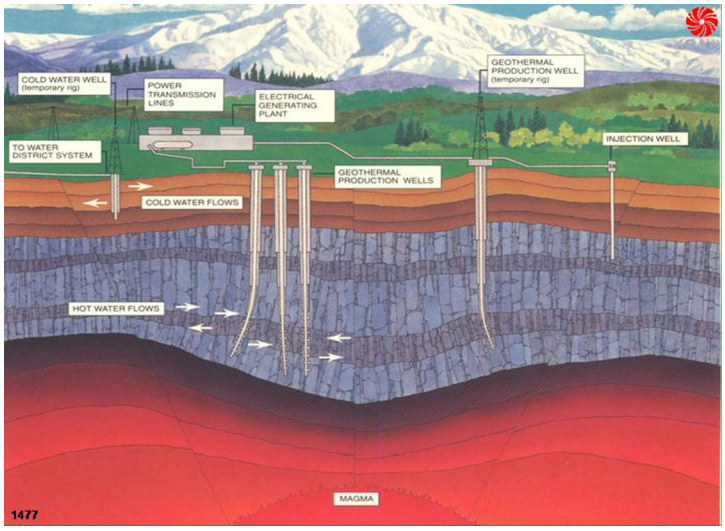


Figure 3: Geothermal Water and electricity harvesting
Source: ORMAT International

2.3 Electrical use of geothermal energy

From earliest times, people have used geothermal water that has flowed freely from the earth's surface as hot springs. Today wells are drilled into the geothermal reservoirs to bring the hot water or steam to the surface. Geologists, geochemists, drillers and engineers usually do a lot of exploration and testing to locate the underground areas that contain this geothermal

water in order to know where to drill geothermal production wells. The hot water and/or steam that travel up the wells to the surface can then be used to generate electricity in geothermal power plants or for energy saving non-electrical purposes such as for hot water. Geothermal power plants use heat or hot water from geothermal reservoirs to provide the force that spins the turbine generators to produce electricity. The used geothermal water is then returned down the injection wells into the reservoir to be reheated in order to maintain pressure so as to sustain the reservoir.

2.3.1 Advantages of electrical uses of geothermal

There are several advantages that could accrue from the use of geothermal energy. Geothermal power plants, like wind and solar power plants, have been found to be a source of clean energy with the following advantages:

i Geothermal is environmentally friendly

Geothermal plants do not burn fossil fuels to turn turbines. Decrease in use of fossil fuels, reduces gaseous emissions that harm the atmosphere. There is no smoky air around geothermal power plants and they can be built in the middle of farms and forests, and share land with cattle and local wildlife. In the United States for example, for ten years, Lake County, California, which is home to five geothermal electric power plants, has been the first and only county to meet the most stringent governmental air quality standards in the U.S.

ii. Geothermal saves foreign exchange and has no fuel inputs into its price

As earlier noted, geothermal power plants do not use fuel to power them therefore, they help save money that the country would spend on importing fuel. The geothermal "fuel'' - like the sun and wind - is always where the power plant is; economic benefits remain in the region and there are no fuel price shocks.

iii. Provides energy diversity and opportunity for supply to grow with demand

Developing geothermal provides energy diversity and reliable base-load power, decreasing risks of supply breakdowns, cost fluctuations and outages. Geothermal power plants are flexible; provide cost-effective energy, even in a moderate scale; and enable incremental development matching genuine demand growth. Geothermal also provides modular increment of energy at remote sites. The plants can have modular designs, with additional units installed in increments when needed to fit growing demand for electricity. This is suitable for Uganda, especially in the rural areas where markets for electricity are not yet developed but indicate a steady growth in demand.

iv Low hazard risk

Geothermal has low hazard risks in case of plant accident compared to gas, hydropower, nuclear and other energy sources.

v Employment opportunities

Geothermal energy is a source of employment in remote areas where it is located. The employment opportunities offered include those in construction, operation and maintenance of the plant. Industries that would spring up as a result of geothermal development would be another source of employment for the communities.

vi Minimal land required and stable energy tariffs

Development of geothermal energy requires little land compared to hydropower. The land area required for geothermal power plants is smaller per megawatt than for almost every other type of power plant. Its installations do not require damming of rivers or harvesting of forests. It does not require creation of mine shafts, tunnels, open pits, waste heaps or oil spills yet it provides a fixed energy price over time. This helps keep tariffs in the power industry stable.

vii. Geothermal energy is reliable

Geothermal power plants are reliable and are designed to run 24 hours a day, all year round. The power plants sit right on top of their fuel source. It is resistant to interruptions of power generation due to weather, natural disasters or political rifts that can interrupt transportation of fossil fuels or disrupt long power lines.

2.3.2 Non-electric uses of geothermal energy

Geothermal waters are used around the world, even when it is not hot enough to generate electricity. Besides hot spring bathing - the most common and the oldest direct use of nature's hot water - is the supply of hot water for domestic and industrial use. The cost of using any other method to keep hot water running continuously through pipes would be prohibitive. In New Mexico, France, Pompei and other places rows of pipes carrying geothermal water have been installed under soil, where flowers or vegetables are growing thereby ensuring that the ground does not freeze, providing a longer growing season and overall faster growth of agricultural products that are not protected by the shelter and warmth of a greenhouse.

Any time geothermal water or heat is used directly, less electricity is used. Using geothermal water 'directly' conserves energy and can also replace the use of polluting energy resources with clean ones. Geothermal waters ranging from 10^0C to over 150^0C are used directly from the earth:

- 'to soothe aching muscles in hot springs, and health spas (balneology)
- to help enhance growth of flowers, vegetables, and other crops in greenhouses (agriculture)
- to shorten the time needed for growing fish and alligators to maturity (aquaculture)
- to pasteurize milk, dry crops and lumber (industrial uses)

Each year 22 million tons of carbon dioxide, 200 thousand tons of nitrogen oxides and 110 thousand tons of particulate matter are not emitted into the atmosphere as a result of avoiding the use of fossil-fuel power generation.

PART 3: GEOTHERMAL ENERGY DEVELOPMENT IN THE WORLD

Since the first geothermal-generated electricity in the world was produced at Larderello, Italy in 1904, use of geothermal energy for electricity has grown. The Worldwide Geothermal Electricity Generation today is about 8,300 MW in 21 countries. About 60 million people, most of them living in the developing world, are supplied with electricity from geothermal. The United States alone produces 2700 megawatts of electricity from geothermal energy; thousands more megawatts of power than are currently being produced can be developed from already-identified geothermal resources. The two greatest untapped geothermal areas of the world are the western coast of South America and the Rift Valley region of East Africa. In Africa, some countries have developed their geothermal potential. Others are in the final stages of implementation while others are still carrying out research on their geothermal resources.

Kenya was the first African country to use geothermal energy for electricity power generation. It is still the leading producer and consumer of geothermal energy in Africa. Government of Kenya continues to support geothermal development.

3.1 Kenya's geothermal development experience

Exploration for geothermal resources in Africa began in 1956 and gained momentum in the 1960's. Today there are three operational geothermal plants in Kenya that produce a combined electricity output of more than 120 MW of electricity. The three plants are located in Hell's Gate National Park, and include the Olkaria I plant which generates 45 MW and the recently commissioned Olkaria IIgenerating 70 MW, both owned by KenGen and the Olkaria III (OrPower) owned by ORMAT; a United States based company, generating 13 MW but with a license to generate 64 -100 MW under a Build Own Operate (BOO) agreement. Negotiations are underway to increase the power generated by the company. Kenya has plans of increasing its geothermal installed capacity in many areas including Olkaria Domes (Olkaria IV). According to KenGen, "Studies have shown that geothermal energy is the least cost power generation option". KenGen also notes that, Government of Kenya has fast-track geothermal development. Therefore, geothermal is likely to cater for an increasingly larger proportion of the country's power needs. KenGen further notes that 576 MW of geothermal power is planned by the year 2017.

Table 1: Comparison of the different sources of energy.

Energy Source:	Plant	Power output MW	Project cost	Cost per Megawatt (US $)	Jobs per MW generated (Jobs/ Mw)	Plant Decommissioning costs
Large Hydropower	Bujagali Power Project (AES-NP)	200	580,000,000	2,900,000	0.125	Very high
Geothermal	Olkaria II	70	163.500.000	2.335.714	-	Very low
Geothermal	Glass Mountains	49	-	-	0.41	Very low
Cogeneration	Okeelanta	74	194.500.000.	2,900,000	0.46	Very low

Note: The cost for Olkaria II includes cost of 100 Km of transmission line

Source: NAPE study 2004

3.1.1 The KenGen Geothermal facilities

The KenGen-owned Olkaria I commissioned in 1981, was the first geothermal power plant in Africa. It was jointly financed by the Kenyan government, the Commonwealth Development Corporation (CDC) and the International Bank for Reconstruction and Development (IRDB). The plant has capacity to generate 70 MW but it is currently generating 45 MW only, leaving an excess of 25 MW.

Figure 4: Olkaria I Geothermal Plant Control room
Source: NAPE files

Olkaria II, has 13 geothermal sites that stretch from Lake Magadi to Lake Turkana and have a potential of producing about 200MW. The plant has so far drilled 28 wells of which 21 are used for steam extraction and 4 are for re-injection. Its steam field has a capacity to produce about 98 MW of which the plant only utilizes 70 MW, leaving a balance of 28 MW. Currently the plant contributes about 16% of the total electricity of the national grid, plans are underway to add another 4 plants.

3.1.2 The OrPower IV Geothermal facility

Olkaria III (OrPower IV) is owned and operated by ORMAT, a foreign company. It is a binary plant consisting of three air-cooled energy converters. The air-cooled energy converter units utilize two-phase geothermal fluids comprising of steam and separated brine. This system ensures sustainability of the resource by avoiding depletion of the aquifers. It also ensures zero surface discharge through re-injection of water back into the crust via injection wells. The first phase of OrPower IV included drilling of five appraisal wells which were entirely financed by ORMAT and World Bank through risk insurance by MIGA. The power plant has been in commercial operation since August 2000.

Figure 5: Olkaria IV Geothermal (Binary) plant operated by OrPower IV (ORMAT)

3.1.3 Social and Environmental impacts of Geothermal development in Kenya

a) Social impacts

Both OrPower IV and KenGen geothermal facilities are located in the Olkaria geothermal region situated in a National Game Park.However, both companies did not displace settled communities from the areas that were developed. Part of the land where the plants were installed is claimed by the Masai community. Being nomadic pastoralists the Masai have used the area for grazing animals and other activities. However, geothermal development in the area affected these pastoral activities. The area, despite being an ancestral grazing land for the Masai, they unfortunately do not have legal rights over it; National Parks are owned and controlled by government. The Masai, therefore, would not claim for compensation from the developers. If they were to be compensated, it would be the responsibility of government. Moreover the Masai communities have not benefited from the energy generated in their ancestral land. These companies are licensed to generate power with no mandate of distributing it to the communities. The power generated is sold to the Kenya Power and Lighting Company (KPLC), which evacuates it from the area without meeting the energy needs of the local communities.

Figure 7. Mr. Mabwa Ernest (third left - white helmet) of OrPower IV explains to NAPE staff how a binary geothermal power plant works. The plant is a good example of sustainable and environmentally friendly geothermal technologies. *Source: NAPE files*

b) what should have been

done to address some of the social problems

i. Government should have compensated the Masai communities upon gazetting their grazing land;

ii. Government of Kenya through Kenya Power and Lighting Company (KPLC) should have developed a strategy of meeting local energy needs; and

iii. Government together with the companies involved in electricity generation in the Olkaria Geothermal region in consultation with the local communities should have drawn a participatory community development plan acceptable to all as well as a collaborative mechanism to address other community concerns.

c) Local Community Benefits from OrPower IV

As a community development initiative, ORMAT contributes towards building of schools and payment of teachers' salaries in some schools within the Masai area. ORMAT promotes education of girls among the community by paying school fees for at least 3 identified girls among the Masai community of Kenya. ORMAT has also made it a policy to draw part of its work force from the Masai community; depending on the available expertise amongst the community.

d) Environmental Impacts

KenGen and OrPower IV are faced with some environmental challenges. The location of the plants in the National Park exposes the power generating companies to challenges of sustainable management of the environment. NAPE assessment of the plants, revealed that the KenGen-owned plants emit some Hydrogen Sulphide (H_2S) a gas which makes the enviroment around them smelly. The plants also release a lot of noise, which pollutes the park environment. The binary plant of OrPower IV, when compared to Olkaria I and II was found to produce less noise and no H_2S emissions into the atmosphere.

In brief, the main environmental challenges of the three geothermal plants to the park environment are:-

- Degradation of the habitats in the National Park where the power plants are located
- Both KenGen-owned plants of Olkaria I and Olkaria II emit H_2S into the atmosphere giving the environment a bad odour.

Figure 8. The 45MW Olkaria I Geothermal plant is the first geothermal power plant in Kenya. The plant has been undergoing transformations to address environmental and social concerns. Plans are also underway to increase on the power generated by the plant ***Source:*** *Business Council for Sustainable Energy (BCSE)*

- Interference with migration routes of wildlife, resulting from the running steam pipelines from the geothermal wells
- Giving an artificial ecological outlook to the National Park, an area that would have otherwise been preserved in its natural ecological set up
- Noise pollution from the plant interferes with the wildlife

e) Mitigation measures to Environmental Impacts

To mitigate the negative impacts of their activities in the National Park, OrPower IV and KENGEN have put in place certain measures which are outlined bellow:

- Planting and maintaining indigenous tree species within the national park
- Identifying the migratory routes of the wild animals and ensuring that these routes are left as secure as possible to allow for wildlife passage
- Recycling of brine and minimising open discharge into the environment, especially at Olkaria I and II which plants do not use the binary geothermal exploitation system
- Covering pipes with camouflaging materials that blend into the park environment
- Ensuring that the levels of noise pollution are kept as minimal as possible

3.2 Lessons and Experiences from Geothermal development in other parts of the world

There are a number of lessons that Uganda can learn from other parts of the world that have developed their geothermal resources. From some of the experiences, it can be noted that:

- There is need for close collaboration between the public and private sector
- Sharing risks between developers and government is essential
- Both the public and private sector should be prepared to halt a project if the results are unsatisfactory
- The ownership of the resource should remain in the hands of Government
- Government should use competitive bidding procedures for Independent Power Producers
- The project size should be based on a sustainable resource capacity and not on pre-determined blocks

PART 4: EXPLORATION AND

PROSPECTS FOR GEOTHERMAL DEVELOPMENT IN UGANDA

4.1 Exploration Processes

Geothermal studies in Uganda started in the 1930s. By 1935, 46 hot and mineralised springs had been identified. In 1982, the country's theoretical potential was estimated at about 450 MW in the Rift Valley System. There is hope that Uganda's technical potential will prove to be higher than the theoretical potential. Several prospects have been identified in different parts of the country with varying potential in the Rift Valley system. Geothermal resources today offer employment to many rural communities especially in the salt extraction industry. If these resources are commercially developed, they are likely to lead to new investments and generate employment opportunities to the local population.

Intensive faulting, often accompanied by volcanic and seismic activities, marks the Rift Valley. Studies done on three sites (Katwe, Buranga and Kibiro) indicate that Uganda has the potential for commercial production of geothermal energy. Of the three areas, the Katwe resource has shown the greatest potential, due to a powerful heat source characterised by volcanic and tectonic features. Geological and geochemical methods were used on Katwe - Kikorongo, Buranga and Kibiro, with the aim of selecting one of the geothermal areas for further surface geophysical analysis and exploratory drilling. The studies revealed that these areas have the capacity to provide energy for local area consumption and the potential for feeding the national grid. Detailed geothermal utilization studies done during the Geothermal Exploration I (GEEP I) to make the first evaluation of the potential of geothermal energy in Uganda arrived at the conclusion that all three areas could be suitable for both electric power production and direct use of geothermal heat.

4.2 Prospects for geothermal Development in Uganda

In 1954, drilling was carried out in Buranga. It was found to have the highest natural flow. Subsurface temperatures, however, are estimated to be in the range of 120-150^{0}C. The Kibiro prospect has limited surface area manifestations but the subsurface temperature of over 200^{o}C is the highest of the three areas. In 1972, the chemical analysis of the Katwe-Kikorongo thermal waters by United Nations inferred a reservoir temperature of 190^{0}C and the field was recommended for economic exploitation. In 1973, an attempt was made to initiate a geothermal project with the UN support, but did not materialise. The subsurface temperatures of the prospect have been estimated to be in the range of 120-150^{o}C. All the prospect areas are situated in remote areas that are far away from the national grid and could therefore benefit from a local source of electricity.

Between 1993 and 1994 studies were carried out by the Geological Survey and Mineral Development (GSMD) and the United Nations Development Programme (UNDP) on the geological and geochemical characteristics of Katwe-Kikorongo, Buranga and Kibiro. The two prospect areas of Katwe and Kibiro were found to have the potential to produce electricity to supply to the national grid while the third one of Buranga has the potential to supply Bundibugyo District with electricity and enough thermal power for drying of agricultural products.

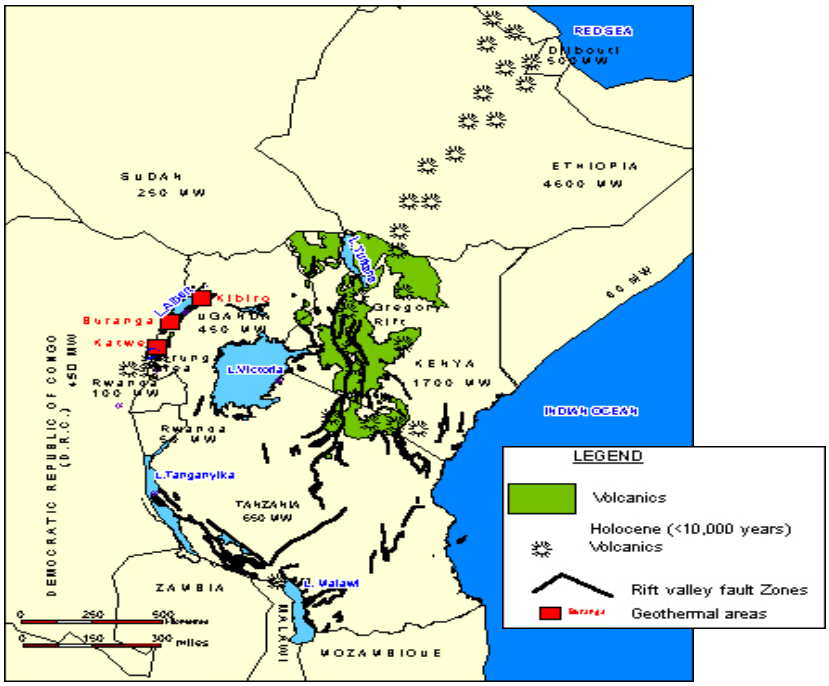
Recent studies, which focused on these prospects indicated that the three areas are regions of unique flow of thermal water and are considered to be potential geothermal targets. The

geothermal activity is clearly related to the tectonic and volcanic activity of the rift. All the hydrothermal systems appear to be relatively old and rise from volcanic basement rocks rather than overlaying sediments. At Katwe, the size of the volcanic field, the high subsurface temperature of about 200^{0}C, as well as various geological observations and proximity to the national grid make the prospect attractive for grid-based electricity production. The Buranga prospect appears to have a significant volume of water at 120 -150^{0}C or more, and may be appropriate for electricity generation and/or a plant for drying agricultural products.

Figure 9. Location of the three main geothermal prospects of Uganda

Source: *Ministry of Energy and Mineral Development (MEMD)*

Studies aimed at upgrading the geochemical model by defining flow characteristics of



geothermal, surface and ground waters on the three areas of Katwe-Kikorongo, Buranga and Kibiro are still going on.

4.3 Possible impacts of geothermal development on governments' rural development programmes

Because many rural communities near the geothermal sites do not have access to safe and clean water, development of geothermal can be used for pumping safe and clean water. Geothermal will also provide hot water, thereby saving on both fuel wood and the time women spend gathering firewood to boil water. Improved quantity and quality of water supply will greatly benefit the lives of rural communities.

There is a high level of in-house pollution in the country resulting from use of fuel wood. In-house pollution has been identified as the major cause of respiratory problems. Women and children are the main victims of exposure to this kind of pollution. Use of clean energy

from geothermal and other sources for cooking and lighting can reduce use of fuel wood, a major cause of this problem.

Rural women mainly depend on farming for their income while their husbands look for casual or formal employment. Providing agricultural processing plants will greatly improve food security, market access and on the incomes of rural women the majority of whom practice agricultural activities. This will, in turn, create an atmosphere conducive for development of micro projects, which are a major source of employment and income for many rural and urban women.

Geothermal can enhance education standards in rural areas, especially for girls, whose work-load on fuel wood collection and cooking is likely to be reduced by its use. By providing good and efficient light, rural children are able to compete with their counterparts in urban areas who have had access to hydro-electricity. Access to and use of computer and Internet facilities will be improved, thereby enabling rural communities to share and learn from experiences elsewhere.

Geothermal development is associated with a number of direct and indirect benefits, both to central government and to the local governments' plans to fight poverty through enterprise creation and employment opportunities (directly in the plants and in the new enterprises). Improved employment opportunities in rural areas will greatly improve the socio-economic status of the communities and their livelihood quality reflecting real development of the rural areas.

The locations of geothermal resources as a decentralised source of clean energy make them ideal for meeting the energy needs of rural communities. Most of the places where these resources are located are not connected to the national grid and would be effectively served by energy from geothermal. Geothermal will compliment the countrys hydropower resources because of its geographical location in the rural areas. Large hydro in the country has had limited impact in the transformation of rural areas because of the high transmission costs involved in taking power to these areas.

Geothermal will provide power security to the country, which now relies mainly on two hydropower stations along the Nile. It has the advantage of being developed incrementally in small units as it is needed. It will also improve power generation for the industrial sector in the country and provide reliable and clean power for the export market. Since the geothermal resources are close to areas of the Democratic Republic of Congo (DRC) which do not have electricity; especially in the eastern parts of the country, some surplus electricity could be exported to that country, thereby earning Uganda some foreign exchange.

Most prospects are characterized by an ancient salt industry utilizing saline water, which percolates through the sediment. This could be upgraded to a modern industry. In addition to salt extraction and power generation, geothermal energy could be used to substitute use of the scarce wood to dry fish, tea and crops, cure tobacco, process sugar and mineral recovery. Some of the waters in these areas with low total dissolved solids could be used as mineral water.

The areas where geothermal resources are located practice agriculture and are far away from markets where fresh agricultural produce are needed. Today one of the greatest losses of crop yields in the agricultural sector is attributed to post-harvest losses. This makes geothermal an important resource to develop so as to save on the massive post-harvest losses. Fish is a perishable good whose markets are often located far away from the areas of harvest. It requires that processing plants are provided to the fishing communities if they are to make a meaningful and sustainable fishing business.

Geothermal projects can offer all of the above benefits to Uganda, as well as allowing the country to develop and grow without the negative social and environmental impacts associated with traditional hydro electricity energy projects. Geothermal installation in remote locations can help raise the standard of living and the quality of life in the rural areas by bringing electricity to people who are far from the national grid.

4. 4 Challenges to Geothermal Development in Uganda

The main challenge to geothermal development in Uganda is that its development continues to be considered more expensive than hydropower. This, however, ignores not only the reality that geothermal is often of lower-cost than hydropower but also the numerous benefits it offers. Today, geothermal energy is being generated at a low cost almost equal to that from hydropower; ORMAT is generating power in Nicaragua from its 35 MW Momotombo plant at 4.79 US cents per kWh due to active government support. This has enabled government to save 90.000 tons of fuel and avoid 120,000 tons of CO_2 emissions. If geothermal development enjoyed adequate support from government; as is the case with hydro, it would offer better energy prices.

There is inadequate data on the various aspects of the nation's geothermal energy resources (availability, quantity, quality-resource characteristics) and the lack of set national targets within which the country's renewable energy resources can be developed. Geothermal exploration processes have been slow compared to neighbouring Kenya. The delays in the exploration process in Uganda can best be explained by the country's high emphasis on large hydropower development.

It is true that geothermal exploration processes are expensive. However, at the same time, there has been limited funding for geothermal development. Most donor funding to the energy sector mainly benefits conventional energy sources. In addition, there is a lack of local geothermal expertise, leading to over-dependence on expensive foreign skilled labour and equipment unaffordable to a poor country like Uganda.

Some geothermal resources in Uganda are located in environmentally sensitive areas like the National Parks, making their development a contestable issue. Lack of information on the available environmentally friendly and modern geothermal technologies that recycle the brine has also contributed to the limited development of the resource. If more investment enters the geothermal energy sub-sector, costs of the resource will drop.

Figure 10a:
OLD Geothermal Energy Utilisation
characterised by high gaseous emisions and liquid discharge into the environment.

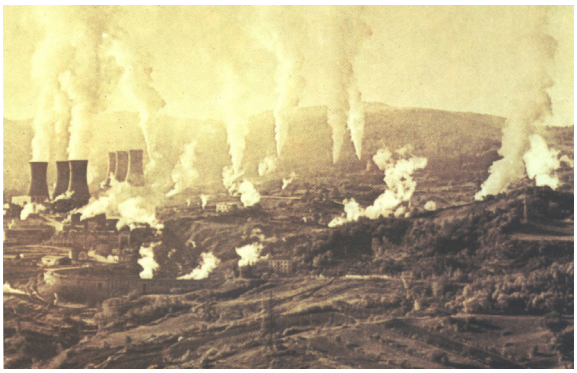


Figure 10b:
New Geothermal Energy Utilisation
with controlled gaseous emisions into the environment.

Until rescently, geothermal has not had a strong local lobby compared to large hydro and other conventional energy sources. The strong and aggressive “lobby” of proponents of large hydropower projects and other conventional energy sources worldwide have had a negative impact on geothermal development. Many major lending institutions have been influenced by proponents of large hydropower and are, therefore, seen to favour it over renewable energy technologies like geothermal.

Despite these challenges, geothermal development is a promising undertaking for the country and offers one viable alternative energy source worthy of investment. Its location in parts of the country that have long suffered from intense energy poverty offers a potential market for geothermal energy. The liberalisation of the energy sector in the country creates a big opportunity for development of the resource through private investments.

PART 5: INVESTING IN UGANDA

Uganda is a fully liberalized economy; all sectors have been liberalised for investment and marketing. There is free inflow and outflow of capital with 100% foreign ownership of investment permitted to interested investors. The country is said to have an average annual economic growth of 6% per annum. It enjoys a unique location at the heart of Sub-Saharan Africa, giving it a commanding base for regional trade and investment. It is a member of the Commonwealth Market for Eastern and Southern African States (COMESA), a region with a market of over 300 million people in 20 countries, and a member of the East African Community which is comprised of Kenya, Uganda, and Tanzania.

The Government of Uganda has stated that it is committed to developing the economy through full participation of the private sector. It has created an enabling environment for dialogue with the private sector in policy formulation. It also facilitates private investment by continuously improving provision of infrastructure and other social services. Investors in the country also enjoy a number of incentives from government to enable them have to profitable businesses. What remains is for government to accept fully that civil society can be a partner in development along with industry and itself to make investment environment more conducive.

5.1 Security of Investment

Security of investment is guaranteed under the Constitution of Uganda 1995 and the 1991 Investment Code. Uganda is signatory to many international investment-related institutions that, among others, include:

- Multi lateral Investment Guarantee Agency (MIGA)
- Overseas Private Investment Corporation (OPIC)
- Convention on the Recognition and Enforcement of Foreign Arbitral Award (CREFM)
- International Centre for Settlement of Investment Disputes (ICSID)
- Agreement on Trade-Related Investment Measures (TRIMS)
- General Agreement on Trade in Services (GATS)
- Trade-Related Aspects of Intellectual Property Rights (TRIPS).

Foreign investors require an investment license from Uganda Investment Authority. The license is very crucial as it is the instrument that legalises investment in Uganda. Investors who register as investment traders are entitled to a Value Added Tax (VAT) refund on building materials for industrial/commercial buildings. Government offers investors duty and tax free import of plant and machinery among others.

The Uganda Investment Authority (UIA), was set up in 1991 to promote and facilitate investment in Uganda. UIA provides firsthand information on available investment opportunities in Uganda and issues investment licenses to investors. The Authority also provides assistance to investors in securing other licenses, secondary approvals, acquisition of industrial land as well as helping them identify business partners. The authority may also assist investors to implement their project ideas through locating relevant project support services and funding.

5.2 Registering investments in Uganda; steps to be followed

- **Step 1 – Register your company in Uganda**

  Investors are required to register their companies in Uganda at the Registrar General's office and obtain a memorandum and articles of Association, and a Certificate of Incorporation

- **Step 2- Get your Investment License**

  Applications are made for an investment license using UIA Form 1 with a brief Business Plan attached. The normal processing time for an investment license is 2-5 days

- **Step 3- Secure necessary secondary clearances**

  Certain sectors require secondary license, UIA assists investors to secure these licenses within reasonable time. UIA also assists investors in obtaining suitable industrial land and work permits for expatriate staff.

It is however, important to note that after fulfilling the above requirements, the investor is required to comply with the country's environmental requirements as stipulated in the National Environmental Management Statute. The National Environmental Management Authority (NEMA) is the clearing house for all environmental issues in the country and works together with other relevant lead agencies to play its role effectively.

More information can be got from:

5.3 Some requirements for geothermal developers

Uganda Investment Authority (UIA)
The Investing Centre
E-mail: info@ugandainvest.com
Web: www.ugandainvest.com

National Environment management Authority (NEMA)
E-mail: info@nemaug.org
Web: www. nemaug.org

There are several key non-technical requirements that may create an enabling environment for the development of Private Geothermal Projects in Uganda. Some of these requirements are not limited to but may include the following:

- The need for Government and other stakeholders to understand why the economy needs geothermal energy. There should be the will to implement policies and measures needed for geothermal development. No private investor will invest in the development of the resource if prevailing conditions are not favourable
- The need to assure the private developers of security for their investments in the country. Private investors always take calculated risks and can only

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think of investing only if there is a clear geothermal development roadmap

- The need for creating room for Public-Private Partnerships for development of the resource
- Creation of a “level playing field” between and among other energy sources; that is:

    a) Between geothermal and other renewables;
    b) Between all renewables and fossil fuel power; and
    c) Between private developers and state-owned developers.

PART 6: Recommendations and

Guiding Principles

6.1 Recommendations

The Civil Society Organisations (CSOs) recommendations below are aimed at promoting transparent, participatory and sustainable geothermal development approaches, plans and systems. Whereas CSOs recognise the numerous and likely benefits from geothermal development, it is also mindful of unsustainable geothermal development practices that may result into a number of negative social, cultural, environmental and economic impacts.
CSOs are committed to sustainable energy development and working in partnership with all stakeholders to achieve this objective. However, CSOs will not welcome geothermal developments that do not embrace the principles of sustainable development or projects that are designed in such a manner as to deprive the local communities and the country as a whole, the opportunity of sharing the benefits of geothermal development. CSOs in Uganda, therefore, recommend that:

- Geothermal funding and development in the country be done in a responsible manner, taking care of accepted best practices. Developers should recognise the need for sustainable utilisation of the resources as well as the need for improved welfare of the communities that depend on these resources for their income and livelihoods. Geothermal development, should be planned in such a manner as to meet the needs and aspirations of the people
- Geothermal development processes should adhere to set national environmental guidelines, be transparent and solicit for genuine stakeholder participation in all project processes. Development of the resource should be based on merit and in accordance with the internationally accepted best practice of competitive bidding
- Government should address legal, policy, and institutional weaknesses so as to promote exploration, sustainable exploitation and use of geothermal resources
- Developers should take the responsibility of disclosing the technology to be used and demonstrate its advantages and disadvantages over other technologies; with emphasis on the impacts of the chosen technology to the environment. Environmentally friendly technologies should be used with clear and action oriented mitigation measures to identified environmental problems in the Environmental Impact Studies (EIS)
- The project should have monitoring mechanisms that involve civil society and other stakeholders, without biasing monitoring to government institutions only
- All geothermal development processes should promote openness, transparency, accountability and be corruption free in project design, EIS implementation, monitoring, tendering and other related processes. The projects and their developers should be identified based on merit and discarded based on their demerits
- The environmental, political, social and economic risks of the project to the local communities and to the country should be made known to the stakeholders. The project's contribution to the national debt burden should be disclosed and debated by all interest groups. Government and developers should be in position to disclose information in good faith on the identified potential risks associated with the

development of the project to the local communities and other stakeholders. In a similar manner, the identified mitigation measures to the project risks should be discussed and made acceptable to stake holders

- The geothermal development initiatives should have a social and an economic development plan for the communities located in close proximity to the resource. The resource development should be of benefit to the local communities who have for long earned their livelihood from it. The project developers therefore, should declare their socio Programme(s) that directly or indirectly address the local population,s development needs
- Environmental Impact Studies (EIS) and other project processes should be carried out without political interference or any other forms of government influence in technical processes. Political interference in project development processes has often compromised and undermined objective decision-making for sustainable use of natural resources
- Depending on the available employment opportunities and the locally available skills in such an area, the developers should as much as possible offer employment priority to the local population before importing labour from outside the project area
- Whereas we realise the need for the developers to profit from their investments in geothermal, the cost of the generated power should be affordable to the local communities. This, therefore, calls for disclosure of the contents of power purchase agreements (PPA) for discussion and input from stakeholders
- Projects must not harm the socio-cultural linkages of the resource to the communities in the project area. The technology used therefore, should as much as possible, avoid compromising other social, economic and environmental benefits of the resource to the local communities and to the country. Consideration should be given to other potential benefits from the resource and therefore the need for sustainable development of the resource
- The developers should, in a participatory manner, develop a plan for fair compensation and resettlement of any of the affected persons or communities in the project area. The plan should allow for participation of civil society and other stakeholders in the monitoring processes of the project implementation

6.2 Guiding principles to geothermal development in Uganda

To meet the principles of sustainable development conveyed by and embedded in the above recommendations, Civil Society in Uganda has developed some basic guiding principles for geothermal development for developers, CSOs, government and other stake holders. Best practices may not be limited to the guiding principles below but may include any other accepted good practices. The guiding principles have been developed in accordance with government legal provisions shown below.

The National Environment Statute, Published in 1995, Entebbe Uganda (GoU)

2. The National Energy Policy, Published in 2002, MEMD Kampala, Uganda
3. The Water Statute, Published in 1995, Entebbe, Uganda (GoU).
4. The Uganda Wildlife Statute 1996, Entebbe, Uganda (Ministry of Lands, Water and Environment).
5. The Environment Impact Assessment Regulations, 1998, Entebbe, Uganda
6. The Land Act, 1998, Entebbe, Uganda
7. The electricity Act, 1999, Entebbe, Uganda
8. The Local Government Act, 1997, Entebbe, Uganda
9. The Environment Assessment Source Book: Guidelines for Environment Assessment of Energy and Industry Projects 1991, Washington D.C. USA. (World Bank)
10. The Mineral Policy for Uganda 2001, Kampala, Uganda (MEMD)
11. The Environmental and Social Management Framework for Energy for Rural Transformation Programme, Kampala, Uganda.

6.2.1 Guiding Principle 1

There is need for political commitment to develop and implement a geothermal policy for the sustainable development and use of the resource.

The country should develop a national geothermal policy that puts forward a clear geothermal development strategy; a strategy that local and national authorities can continuously apply to meet the energy needs of the rural communities and the country as a whole. The strategies developed should be mutually supportive to geothemal development taking care of the concerns of the different stakeholders.

Procedures:

- Developing fair compensation procedures for the affected communities as well as contingency planning in geothermal development
- Developing mechanisms of transparency in project development processes
- Promoting public awareness on both the negative and positive impacts of geothermal development

6.2.2 Guiding Principle 2

Design and enact appropraiate law(s) to promote sustainable use of geothermal energy and non- energy uses.

- Addressing the legal constraints to the development of geothermal resources in the country
- Widely consulting, discussing and harmonising all legal constraints to geothermal development with the various stakeholders especially the Uganda Wildlife Authority
- Developing mechanisms and the capacity of implementing the law(s)
- Raising awareness amongst the lead agencies and the public on the law

6.2.3 Guiding Principle 3

Build partnership and confidence for the development of geothermal within and among the communities, local authorities, developers and other stakeholders

The development, implementation and use of geothermal energy should be a product of partnership and participation of all stakeholders in order to ensure confidence and trust amongst the stakeholders and the industry. Sustainable development is a collective responsibility of the various stakeholders and requires an integrated approach; an approach that is embraced and developed in a participatory manner in partnership with the various stakeholders. Stakeholder participation and partnerships help in building consensus which is important for geothermal development.

Procedures:

- Identifying stakeholders and creating space for participation
- Mobilising and disseminating of information to identified Stakeholders
- Organizing and holding consultative meetings on the proposed development
- Formation of focus/working groups
- Consensus building/development on the way forward

6.2.4 Guiding Principle 4

Promote a Participatory development, implementation and review of geothermal development strategies and plans in Uganda.

The strategies should provide room for looking at the problems, their mitigation measures and the suitability of the mitigation measures to the problem in question. Monitoring mechanisms should be developed and aspects of institutional strengthening of relevant government addressed. Issues of compensation to the affected communities should be realistically addressed in the strategy and should be in accordance with the available laws. Efforts should be made by the developer and government to disclose the socio economic benefits of developing the resource to the local community.

Procedures:

- Consultative meetings/workshops with affected communities, local leadership and other stakeholders on one hand with government and developers
- Prioritization of issues
- Develop and popularise the plan of action and its proposed implementation
- Disseminate the monitoring and evaluation plan indicating participation of interest groups

6.2.5 Guiding Principle 5

Address and integrate people's cultural and spiritual concerns into geothermal development through Regular consultations and consensus building processes with the affected communities and other stakeholders

Peoples' cultural and spiritual wealth should be respected, promoted and, where possible, integrated in development programmes. To do this, both government and the investor on the one hand and the communities on the other hand should develop an acceptable way forward to all the concerned.

A strategy to disseminate information as well as gathering feedback should be put in place to enhance communication between developers on one hand, the communities, local leaders and other stakeholders on the other hand. Measures should be put in place to address the issues arising from the communication strategy. This would also help address emerging problems and communicate possible remedial actions both technical and non-mechanical.

Procedures:

- Study and understand cultural, spiritual and environmental issues in the areas where resource development is to take place
- Develop a suitable communication and awareness strategy and materials on issues of culture in relation to development
- Form joint consultative committees involving developers, local leadership, communities and other stakeholders
- Develop an appropriate response strategy to the generated feed back

6.2.6 Guiding Principle 6

Develop capacity for low cost local geothermal technologies by promoting practical geothermal education among the learning community and encourage development of small-scale geothermal energy industries /technologies

To reduce on the presumed high cost of geothermal development, measures to address development of appropriate indigenous technologies for sustainable geothermal harvesting should be put in place. The initial capacity-building would address local fabrication of spare parts of the plant as well as developing technologies for the recovery of other resources in the brine. Other complex geothermal machinery should also be developed in the long term. The need for technological development calls for close cooperation between government with research and institutions of higher learning and other stakeholders. It is important to demonstrate practically how the various technologies will be domesticated. This requires technology transfer units that are easily accessible and conveniently placed demonstration units targeting local engineers and technicians.

Procedures:

- Establish linkages with learning community and provide funding for geothermal research
- Encourage collaborative working relationships with technology sources for technology transfer
- Develop a geothermal technology transfer centre(s) in collaboration with the investors
- Promote and fund local scientists and innovators to develop home grown technologies as well as domesticating imported technologies
- Encouraging and facilitating local manufacture of simpler components of the imported geothermal machinery

6.2.7 Guiding Principle 7

Implement and constantly review the national geothermal strategy for sustainable development of the resource

CSOs realise that the current energy poverty in the country is contributing to environmental degradation and to unsustainable economic development. Most rural areas today do not have access to modern energy supply to enhance agricultural production as well as to supply energy for processing agricultural produce. However, geothermal development requires a strategy that is clearly thought out and continuously assessed to ensure that its development does not degrade the environment. This strategy should have monitorable indicators and be open to monitoring of stakeholders. There should be mechanisms for response areas as much as possible as well as their natural environmental conditions. Exposure to the brine of both fauna and flora should be minimised. The strategy should, therefore, promote a collective responsibility towards sustainable harnessing of geothermal resources in the country.

Procedures:
To implement this principal, a number of prioritised actions have been identified:

- Develop practical strategies for affordable and modern energy supply to enhance rural energy supply for agricultural production
- Promote transparent and independent reviews by stakeholders
- Maximise development of the geothermal resource to meet the energy needs of the rural populace
- Minimise risks to fauna and flora through objectively/professionally produced environmental impact studies (EIS)
- Promote resource recovery from the geothermal fluid before its discharge or injection into the geothermal wells

6.2.8 Guiding principle 8

Promoting sustainable use and disposal of the geothermal fluid in such a manner as to conserve the environment

Resource recovery from the geothermal fluid provides a diversified manner of sustainable use of geothermal resources. However, in the event of lack of expertise and technology to recover any resource from the geothermal fluid, then it should be re-injected into the system discharge through wells to avoid open flow into water bodies. Open flow of the brine into water bodies and the soil could result in harmful environmental impacts.

Procedures:
Planning for resource recovery from the brine to ensure sustainable utilisation of geothermal resources should consider the following:

- Undertake an inventory of the chemical content of the geothermal fluid at all geothermal prospects
- Assess and evaluate existing technologies based on their ability to generate power and/or whether they provide opportunity for other benefits
- Assess and train local experts on the required skills for resource recovery
- Introduce identified resource recovery technologies in geothermal areas
- Market the recovered resources both locally and internationally

6.2.9 Guiding principle 9

Promote sound environmental management practices during exploration, implementation and operation of geothermal projects in Uganda.

The Government of Uganda, through NEMA, should continuously assess and enforce sound management practices. Developers should be encouraged to implement their projects in such a manner as not to harm the environment or the lives of communities close to the prospects being developed. In situations where the geothermal resources are located in ecologically sensitive areas, resource developer should consider mitigation measures that preserve the natural conditions of such areas as much as possible.

The opportunity costs of developing the resource as well as any other economic information should be disseminated to the public. The health and environment issues arising from the proposed projects should be disclosed and mitigation or precautionary measures put in place. It is important for the following issues to be considered when planning and managing geothermal plants in these areas.

Procedures:

- Ensure that EIA guidelines in MEMD capture the geothermal energy option

- Carry out economic studies and disseminate findings to stakeholders
- Acquire land from the prospective owners
- Undertake objective and transparent EIA study process
- Study the geology and the hydrology of the area identified for development
- Explain the technology/development methods to be used to stakeholders
- Monitor the exploration, construction, operation and maintenance processes of the plant
- Monitor the impacts of the plant on the flora and fauna as well as other ecological factors
- Planning for restoration should be undertaken before and when the project closes, with continued monitoring and evaluation of the closed prospect

6.2.10 Guiding principle 10

To promote efficiency in geothermal plants through proper plant operation and maintenance

Efficiency in production processes is important for sustainable use of resources. Sustainable use of geothermal resources in Uganda will require that efficiency in production and exploitation is encouraged and promoted. This could be done through periodic monitoring of levels of emissions at geothermal sites for liquid and gaseous emissions. This monitoring would help reduce and control levels of pollution and plant accidents to avoid negative social, economic and environmental management problems. The monitoring levels would be determined by the overall presumed impacts of the resource to be developed.

Procedures:

The monitoring should involve:

- the temperatures of the wells
- thechemical and physical parameters e.g. the pH, Salanity and conductivity of the plant effluents
- the impact of discharge on the quality of the local water supplies, fauna and flora and the local communities
- the tectonic behavior of the area e.g. volcanicity

6.2.11 Guiding principle 11

Promote transparency and accountability in the development of geothermal energy and other non-energy processes in Uganda.

Development projects should be implemented in such a manner as to uplift the people's standards of living. However, several projects have failed to achieve this objective. Instead they have contributed to increased suffering of the people they are intended to benefit. The manner in which matters of public interest are conducted has often down-played responsibility in the form of transparency and accountability. Transparency and accountability has been lacking in previous energy projects but are crucial aspects of geothermal development projects. Government development partners and other stakeholders have a duty and responsibility of ensuring that geothermal projects are executed in the most transparent and accountable manner.

Past development projects have disregarded the practice of accountability and transparency to the public leading to heavy losses of public funds and other resources. The structures that enhance the practice of accountability and transparency by policy makers, investors and financial institutions to the public are inadequate yet it is important for policy makers, investors

and financial institutions to account to the people for the negative social, economic and ecological impacts of their projects.

Procedures:

- Collecting business profiles of the prospective investors
- Developing information dissemination mechanisms in the relevant institutions
- Providing relevant business information to stakeholders for informed participation
- Adhering to project criticism and implementing stakeholders recommendation
- Providing room for independent non government institutions to monitor and review issues of accountability and transparency in project processes
- Promoting independence of government institutions involved in accountability and transparency issues
- Facilitating and strengthening government institutions involved in accountability and transparency issues

6.2.12 Guiding Principle 12

Address and integrate concerns of gender and other marginalised and vulnerable groups in geothermal development Programmes.

Government and developers should be sensitive to the concerns and needs of all categories of people within the areas that are to be affected by the project. Special attention, however, should be given to women and to other disadvantaged and marginalized groups in society such as children, youths and people with disabilities.

The developers and government should investigate on the likely impacts of the project on the marginalized and disadvantaged people and engage them into a consultative process to establish their needs and concerns. Measures to address the identified concerns and needs should be worked out with the full participation of these groups and a way forward developed in consensus with these groups.

The final decisions on development of geothermal projects should be sensitive and responsive to identified concerns and needs of women and other disadvantaged and marginalized groups in society such as children youths and people with disabilities. The developers should give due consideration to the imbalances in resource use and ownership among the affected communities with specific emphasis on women and other disadvantaged and marginalized groups in society.

Procedures:

- Study and understand the gender relations in the areas where geothermal development is to take place
- Carry out awareness campaigns on gender relations and property rights among the affected communities
- Identify the vulnerable and disadvantaged groups and develop mechanisms for addressing there concerns
- Form gender balanced consultative committees to include local women community leaders
- Create a strategy for involving all groups including the marginalized category in all stages of project development

7.0: Conclusion

Civil Society in Uganda recognises the prevailing energy poverty in the country, especially in rural areas. We also recognise the need for increased generation and supply of clean, environmentally friendly and dependable energy. We note that geothermal development in the country is vital for energy security and for the numerous socio-economic and ecological benefits it may offer to government and its population. Therefore, we commit our efforts to supporting developers' and government efforts towards sustainable development of the country's geothermal resources.

Studies carried on geothermal indicate that geothermal rich areas are characterised by intensive faulting, often accompanied by volcanic and seismic activities. The history of volcanic activities, together with the current prevalence of intensive faulting, volcanic and seismic activities are indicative of the enormous and dependable geothermal resources in the country, that are required for a sustained energy supply. We realise the danger poised by the continued accumulation of heat in the earth's crust that could in the long run be of negative social, economic and ecological impacts in the country in case an eruption occurred. Geothermal development would probably help stabilise and reduce on the uncertainty in geological conditions of these areas.

The current trends in geothermal development in Uganda are promising and offer opportunity for investment. These initiatives require support of private investors, International Financial Institutions (IFIs), Governments and other stakeholders. Government, however, must move a step further to put in place a comprehensive policy and a supporting law to regulate geothermal development and use. Government agencies, like the Geological Survey and Mines Department (GSMD), Uganda Wildlife Authority (UWA), Directorate of Water Develoment (DWD), the Uganda Tourism Board (UTB), National Environment Management Authority (NEMA) and other relevant agencies, should harmonise their policies to enable sustainable development of the resource.

All development is and should be people's development. Therefore, any plans or projects intended to archieve this should be based on conscious seekers of dialogue, consensus and partnership with the local communities who have, in the past, suffered the consequences of failed development projects. It is absolutely important that every geothermal project developer respects the cultural, spiritual and environmental needs and foundations of survival of the local communities. Not doing so will undermine the thesis that development is people's development.

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