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FORMULATING A GEOTHERMAL ENERGY POLICY, LEGAL AND REGULATORY FRAMEWORK FOR UGANDA

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ABSTRACT

Although geothermal energy prospects in Uganda have been known about for more than 30 years, exploratory drilling for geothermal resources has yet to take place anywhere in the country. The current situation has arisen despite a wide variety of surface studies being undertaken by Government and development partners, and a number of geothermal exploration licenses being issued to private sector prospectors over recent years. In addition, policy commitments have been made in support of the technology, including the availability of a feed-in tariff for geothermal power plants. At least four sites in the country show good signs of the presence of medium- to high-temperature hydrothermal systems, but there are only limited signs that one licensee may be close to embarking on an exploration drilling campaign.

The lack of a clear policy and legal framework which can foster the emergence of the industry is widely considered as a barrier for further developments in the country. The Government of Uganda recognises that it needs to take an active role in supporting the sector. The aim of the policy and legal framework is to, *inter alia*, give clearer direction as to how geothermal energy projects can be developed, by whom, over what time frame, and using which sources of finance and support mechanisms. The legal framework must serve to enact the policy into a binding system that provides clear direction for all involved. It will also clarify the mandate for the newly-established Geothermal Resources Department regarding its role in, *inter alia*, supporting survey and exploration, de-risking steamfield development, coordinating donors and investors, coordinating access to power markets, coordinating access to land and other environmental permits, aligning progress with the national development plan and defining its regulatory function etc.

1. INTRODUCTION

The Government of Uganda recognises the potential benefits of geothermal energy in providing a clean, reliable and secure source of energy, but also the challenges and barriers in getting the technology started. Relying on the current energy policy framework to promote geothermal development, and the mining laws to regulate such activities, is potentially hampering developments. The policy doesn't present a clear enough picture on how geothermal development should proceed, over what time frame, with what financial support and led by whom. Also, the use of the Mining Law to regulate such operations is suboptimal and a dedicated licensing system could improve the way the potential resource is managed. In tandem, the policy and legal framework needs to more clearly define and appropriately allocate risks and rewards between public and private actors. With these issues in mind, the Government of Uganda took a view that a new approach is needed that creates a clearer enabling environment to accelerate geothermal energy development. In pursuit of this aim, the Government, through the National Council for Science and Technology, made a request to the

Climate Technology Centre and Network (CTCN) of the United Nations Framework Convention on Climate Change (UNFCCC) for technical support in formulating a new geothermal energy policy and legal and regulatory framework.

The outcomes from the support programme will help Uganda establish a more coherent framework for geothermal energy development in the country. This includes, *inter alia*, (i) fostering support for the technology amongst key policy-makers; (ii) clarifying the role of different stakeholders in the field, including more clearly allocating risks and rewards between various parties (iii) building confidence amongst investors and donors regarding the framework and timeframes for geothermal energy development (iv) creating trust amongst local communities regarding the safety and benefits of the technology.

2. CHALLENGES FOR GEOTHERMAL DEVELOPMENT

The primary challenge for geothermal energy development is the significant resource uncertainty. This is a major impediment to raising sufficient project finances for the expensive test drilling needed to confirm the presence of a viable resource or otherwise; these costs are fairly fixed irrespective of whether a viable resource is found, and involves substantially higher upfront costs compared to fossil thermoelectric power plants and has greater resource uncertainty compared to hydropower projects. The risks, costs and cost structures involved are also different to other types of renewable energy, with large capital investments needed compared to e.g. off-grid solar PV.

The development phase of a geothermal prospect can also be long, requiring a range of surface studies and shallow drilling to identify the presence and location of a hydrothermal system, usually undertaken over several years. This is then followed by test drilling of deeper, full size wells to prove the resource. This presents the prospect of several years of multi-million dollar spending on geological surveys and drilling of test wells with the risk of little or no return on investment. Additionally, project revenues are typically tied to electricity tariffs, which in many markets are fixed at regulated prices. This means that the upfront investment costs for geothermal energy are high and payback periods for projects can be long and uncertain.

The risks and challenges described are further augmented for greenfield, first-of-a-kind (FOAK) projects in a new geothermal prospect or, in particular, a country with no experience in bringing a geothermal project through the development cycle. These characteristics make geothermal energy unattractive for many investors. This is the situation faced in Uganda today.

Notwithstanding the challenges described, more than 12,000 MW of geothermal power generation capacity exists worldwide, covering more than 25 countries and involving more than 700 individual geothermal power generating plants: experience around the world clearly shows that such problems are not insurmountable. In nearly all cases, strong government policy has been critical in establishing the technology, as discussed further below.

2.1 Experiences with geothermal development around the world

The Government of Uganda is committed to evidence-based policy-making. In pursuit of this commitment the project team undertook a detailed review of worldwide experiences in geothermal energy development. The review sought to gain insight into the drivers for geothermal development and the approaches used to finance projects and structure investments.

An assessment of FOAK geothermal projects in Costa Rica (Miravalles, 1994), El Salvador (Ahuachapan, 1976), Ethiopia (Aluto Langano, 1999), Indonesia (Kamojang, 1983), Kenya (Olkaria I, 1980), Mexico (Cerro Prieto, 1973), New Zealand (Wairakai, 1963), Philippines (Tiwi, 1979) and Turkey (Kizilidere, 1984) showed that in nearly every case project development was led by government, either through a state utility or national oil company, and in the case of developing countries, involving technical assistance grants from development partners and concessional loans from bi- and multi-lateral development banks. The exception has been the Philippines where the Tiwi and subsequent Mak-ban steamfield development projects were led by UNOCAL through Philippines

Geothermal Inc. The cost to the public sector of developing these steamfields using private finance prompted the Government to wrest control of geothermal resources back to government through establishment the geothermal arm of the national oil company, PNOC-EDC, in 1976. It only fully opened up the sector again for 100% private investment in 2008 after the construction of more than 1,000 MW of steamfield capacity by PNOC-EDC through the 1980's and 1990's.

A review of private sector led involvement in greenfield geothermal resource development (i.e. steamfields) was undertaken covering Chile (since 2000), Ethiopia (recent years), Honduras (since 1994), Indonesia (since 2003), Kenya (since 1982), Nicaragua (since 2002), Philippines (100% private sector led allowed since 2008) and Uganda (since 2010). In these countries the legal framework has allowed to issuing of contracts/concessions to private developers for geothermal resource exploration in the years indicated. The results suggested that the private sector brought online less than 200 MW of capacity in these countries, mainly in repowering and step-out development projects at existing operational steamfields (i.e. brownfield projects). Only a handful of major private sector led greenfield projects were identified: Kalinga (Philippines, due 2019/20), Sarulla (Indonesia, due 2020), Cerro Pabellon (Chile, due 2017+) and Platanares (Honduras, due 2017+) all of which are have been a long-time in the making. Furthermore, the review noted that the investment structures are usually highly complex involving a wide range of contractual agreements, and often involving "copper-bottom" guarantees from government – such as Implementation Agreements – to backstop the project. For example, at Sarulla a 20 year *Business Viability Guarantee Letter*, issued by the Indonesian Ministry of Finance to backstop PLNs offtake payments was essential to unlocking project finance from the various lenders (PFI, 2014).

The experiences seen worldwide are understandable: the risk profile for geothermal projects means commercial debt is difficult to raise, resulting in private sector development being mainly reliant on equity finance and complex tie-ins and joint ventures with different actors and state-owned utilities. In the event that appropriate risk-taking investors be found – by no means straightforward – the cost of capital is likely to be significantly higher than for commercial loans, making the cost of electricity high and potentially uncompetitive when negotiating an offtake agreement. Feed-in tariffs available for geothermal rarely match the levels needed to payback the high expected returns.

The findings are consistent with others in the literature. For example, Micale *et. al.* (2014) summarised the history of geothermal development succinctly when they concluded that: "*There is little appetite from the private sector to fund projects where the nature and extent of the resource are unknown. The private sector only financed all stages of the project in 7.5% of the utility-scale projects in our database. 58.5% of projects had the costs entirely borne by the public sector, while 34% projects had the private sector bear costs at later stages in the development chain once the resource had been proved.*" and that: "*private financiers are not willing to provide financing until all or at least 70% of the MW capacity has been drilled*"

It is therefore reasonable to conclude that government involvement in geothermal resource exploration is critical to realising the technology, especially for FOAK greenfield sites such as in Uganda. Using public finance to fund project development is also not always straightforward, however, as it exposes government to risks the private sector are not willing to take. For small developing economies, the risk to the national exchequer may be too high to bear alone. More often than not, grants and concessional loans are also needed to support development and ensure that project costs are achieved at a level that results in an affordable cost of electricity.

As highlighted by Micale *et. al.* (2014), the establishment of public-private partnerships (PPP) is also proving effective in raising private investment into geothermal power around the world. In a PPP arrangement, the public sector typically takes on responsibility for steamfield development whilst the private sector takes a lead on power plant construction using various arrangements (e.g. design-build-own-operate; build-own-operate-transfer etc.). The Kenyan *Geothermal Development Company* (GDC) – an institution that continues to pioneer the approach – estimates that the levelised cost of electricity (LCOE) for a fully-privately led geothermal development with a cost of capital of around

25% is in the range US¢14-17/kWh, whereas a PPP approach where the private sector leads only power plant development with the same cost of capital results in an LCOE of US¢6.5-10.5/kWh (Musembi, 2014).

The findings provide important lessons learned for development of the geothermal policy and law in Uganda.

3. POLICIES TO SUPPORT GEOTHERMAL ENERGY DEVELOPMENT

As highlighted above, development of geothermal energy resources is challenging and more often than not requires government involvement. As such, appropriate government policy is critical in terms of, *inter alia*:

- Defining the objectives and ambitions of government in pursuing geothermal technology, thus setting a target in terms of the urgency for deployment;
- Giving direction as to how geothermal energy projects should be developed, by who, over what timeframe, and using which sources of finance and support mechanisms;
- Raising awareness about the technology, the benefits and risks, and providing assurances to local communities about the safety of developments;
- In some cases, setting out a vision for development, such as Geothermal Resources Master Plan or Roadmap.

Within these broad policy objectives, the subtext is that a geothermal policy must outline:

- How risk is going to be shared between public and private actors – and specifically the role of government in de-risking geothermal development opportunities and increasing their bankability;
- How government will facilitate access to sources of finance, especially grants from development partners and concessional loans from development banks;
- How it will work to attract competent and well-capitalised private sector developers and investors who understand the risks and opportunities presented (e.g. through a clear concession process and the use of financial incentives);
- How government will work with local communities to increase understanding of the resource and identifying local benefits for areas where geothermal resources are to be developed; and,
- How research and academic institutions can work with government to promote education and research into the subject in the country. This can raise awareness and understanding of geothermal resources, and build a future workforce capable of constructing and operating plants that maximise opportunities for resource utilisation.

A successful policy for geothermal energy in Uganda will need to address all these aspects.

In reviewing experiences around the world, it was noted than broadly two types of drivers have served to promote geothermal development:

1. *Necessity*. In some situations, such as in New Zealand, Kenya, and Central America, a lack of other obvious sources of energy, and in particular an over-reliance on variable hydro-power, have given rise to the importance of geothermal energy for baseload generation, leading to significant government efforts to get the industry off-the-ground;
2. *Opportunity*. In other situations the quality of the resource has tended to be manifest (e.g. some Central American countries, Mexico, Italy) and information and data on geothermal resources has been acquired as a co-benefit from other activities such as oil and gas exploration (e.g. in Philippines and Indonesia, where geothermal resource development has mainly been led by national and international oil companies). In these situations, geothermal energy has also emerged in response to the clear opportunity presented.

In reality, it is often a mixture of the two, but it useful for governments to be mindful of whether clear drivers exist for embarking on what can be a long, complex and potentially capital intensive endeavour in comparison with other types of power generation technologies.

The nature of driver links directly to policies and strategies government may chose in pursuit of geothermal energy technology: on the one hand, where the necessity is not clear, governments may elect to take an *opportunistic* approach, relying or organic evolution of the industry by the private sector outside of significant, direct, government intervention. On the other, where the *necessity* is clear in terms of the need to meet rising demand for modern energy services, government needs to be proactive in promoting the industry in order to accelerate developments. In the case of the latter, for small developing economies this often means seeking technical and financial support from a range of development partners and banks, as well as injecting significant amounts of public funds as equity into project development. This situation can be seen, for example, in Kenya today, where the government has put several US$100 million into the GDC and used this to leverage several US$100's more investment from bi- and multilateral lending institutions to finance development of the Menengai steamfield.

The two options are not mutually exclusive, however. Government may wish to promote the development of at least one FOAK geothermal project in a new area, whilst in parallel allowing the private sector to develop other areas. Under this strategy, the confidence gained in establishing the FOAK project could act as a catalyst for development across all geothermal prospects in a country, including those under private sector control.

A further feature of geothermal energy policies is that they tend to be *evolutionary*, changing towards more mixed approaches over time as experience and confidence in the technology is gained, and the opportunities for step-out expansion and brownfield development arise. This can be seen in the maturing provinces of Kenya, Indonesia, and the Philippines, for example, where approaches to project development are tending towards greater use of private sector finance at earlier stages of the project development cycle. This means that flexibility in policy is needed, moving from more government led activity in early stages, to mixed and fully private led approaches later on as confidence grows.

But in the first instance, government should consider the urgency to act when deciding whether and how to pursue geothermal resource development. The answer to this question can give clear direction regarding where to start and the expected timeframe for development.

4. REGULATING GEOTHERMAL ENERGY DEVELOPMENT

In most jurisdictions around the world, the *Regalian Doctrine* applies in the constitution, meaning that subsurface resources are owned by the people and managed by government on their behalf. The primary purpose of geothermal energy law and regulation is therefore to vest tenure rights into private sector actors – or parastatal agencies – to explore for and utilise (exploit) geothermal energy resources; essentially a franchising arrangement typical of most resource development laws. Where government is the sole developer, such as in Costa Rica, generally specific laws for geothermal energy are not necessary.

Tenure rights may also be issued under parallel regulations, such as mining laws, although this can create problems in terms of the nature of license given (too long, too short, inappropriate conditions etc.) and the problem of overlap and coexistence (i.e. the tying up of mining concessions with geothermal permits rather than minerals exploration). As such, a number of countries around the world, including Chile (2000), Indonesia (2003), Kenya (1982/1990), Mexico (2014), Nicaragua (2002), Philippines (1978/2008) and Turkey (2007), have all established dedicated geothermal energy laws.

Alongside vesting tenure rights into private actors, other regulatory elements are required to give substance to the rights vested, including:

1. *Powers of government/Minister to declare geothermal resource areas*. This can be useful for establishing the plans for development of an area, and for tendering concessions, if desired.
2. *Methods for allocating concessions*. Using either:

a. Direct approach, negotiated and issued on a first-come-first-serve basis; or
b. Public tender, with various methods by which to award concessions; or
c. Dual systems, with government tendering for resources areas where it has collected significant volumes of data for which it wishes to recover [some] costs, and direct approaches for other less explored areas.

3. *Permitting regime*. Relating to both Exploration and Exploitation licenses terms, renewal and retention arrangements, permit application requirements and procedures etc.
4. *Financial aspects.* Such as fees, royalties and the use of financial mechanisms such as bonds and guarantees.
5. *Regulatory regime*. Defining which authority does what in terms of oversight of concessionaires;
6. *Interactions with other laws*. Such as mining, oil & gas, wildlife, conservation, water, waste, environmental impact assessment, finance (e.g. for fiscal support regimes) etc.

A review of laws in the jurisdictions described revealed a range of characteristics of geothermal laws, a brief summary of which is provided below (Table 1).

Country	**Allocation of Concessions**	**Concession periods**			
		Exploration		**Exploitation**	
		Initial	**Renew/Extend**	**Initial**	**Renew/Extend**
Chile	Dual system	2 years	2 years (>25% progress)	Indefinite duration	
Indonesia	Dual system	5 years (max. incl feasibility study)	1 year (twice)	37 years	20 years
Kenya	Direct request	1 year	1 year	30 years	5 years
		5 years	No limit	Indefinite duration.	
Mexico	Direct request	3 years	3 years	30 years	Indefinite extension
Nicaragua	Dual system	3 years	2 years (>2 wells)	25 years	10 years
Philippines	Public tender	2 years	1 year	25 years	25 years
Turkey	Dual system	3 years	1 year	30 years	10 years

Table 1: Summary features of selected geothermal energy laws

In general, experiences around the world show that a range of methods are used to allocate concessions, and a range of terms are applied to exploration and exploitation licenses, including differing licenses periods, different conditions for renewals, and the use in some cases of financial instruments relating to the issue of exploration licenses.

A number of common problems can be seen with geothermal laws around the world. These include:

- Tying-up of concessions with operators that do not necessarily posses the interest, technical competence or financial capabilities to explore and exploit the resource, i.e. passive speculators. This problem is widespread in Chile, Indonesia, Uganda etc;
- Disputes over land access, and the multiple and often complex frameworks through which developers need to operate. This can usually best be resolved by government, and the use of Implementation Agreements to guarantee timely permitting for private sector developers is quite common;
- General issues relating to requirements around pre-feasibility and feasibility studies, the need for environmental impact assessments and land access permits for government land such as national forests and parks.

These lessons suggest that careful design is needed to ensure that passive speculation is discouraged and that coordination with other permitting authorities is streamlined. The use of financial instruments and the use of short exploration license durations with renewal contingent on showing progress can be effective tools to deter passive speculation. Having a government department dedicated to geothermal energy resources that can act as a "one-stop-shop" to support private sector developers can also be effective in avoiding complex regulatory delays.

5. IMPLEMENTATION IN UGANDA

Drawing on the experiences outlined above, the project team set about designing a specific policy, legal and regulatory framework for geothermal energy in Uganda. The different characteristics of geothermal compared to other energy technologies, and the need to consider local communities where projects may be developed, was key factor in electing to create a dedicated policy. The work involved assessing the current status of geothermal resources within the energy sector in Uganda, and the consultation with stakeholders on possible issues and solutions, as described further below.

5.1 Current status of the energy sector

Uganda possesses abundant energy resources including hydropower, geothermal, biomass, oil and gas and potentially uranium. Gross installed electricity generating capacity at the end of 2015 stood at only 895 MW, however, predominately from large hydropower (>70%). Household access to modern energy services is extremely low, at around 18%, one of the lowest in Africa. Resource potential includes more than 2,000 MW of large hydropower, several 10's MW of small hydro, several 100 MW from fossil (thermal) potential based on future development of hydrocarbons in the Albertine Graben, and maybe several 10's MW from other renewables. Geothermal energy has to compete with these energy sources within the generation mix with a view to meeting a future peak demand forecast of between 1,873-2,722 MW in 2030 (MEMD, 2011). On the other hand, the Government of Uganda has to an extent committed to developing geothermal resources, projecting in the near-term around 33 MW of capacity by the early 2020's (MEMD, 2011), increasing to around 130-150 MW over the medium term by or after 2025 (MEMD, 2015a; MEMD, 2015b) and up to 1,500 MW over the longer term to 2040 (GOU, 2013).

Notwithstanding these ambitions, the existing Energy Policy (2002) and Renewable Energy Policy (2007) make only limited reference to geothermal energy. The latter introduced a feed-in tariff for geothermal <20MW at US¢7.7/kWh, although this price is significantly lower than the tariffs being received on a negotiated basis by hydro and thermal power generators. As such, the policy seems to offer little incentive for investment in geothermal energy, and needs bolstering with other measures.

Uganda unbundled its electricity sector in 1999 with responsibility for generation, transmission and distribution divided amongst three 100% government-owned parastatal utilities: UEGCL (generation); UETCL (transmission) and UEDCL (distribution). In accordance with the Electricity Act (1999), regulation of the sector is overseen by the Electricity Regulatory Authority (ERA), which is responsible for permitting power plant developments. Since 1999 Uganda has introduced independent power producers (IPPs) into electricity supply, with UETCL acting as the single-buyer responsible for negotiating off-take arrangements. As such, the mid- (power plant licensing and construction) and downstream (evacuation of power) aspects of geothermal power development face few barriers in the country. The greatest challenges lie in the upstream (steamfield) development phase.

To address this challenge, the Geothermal Resources Department was created in 2014 within the Ministry of Energy and Minerals Development to spearhead development of geothermal resources in the country. Presently its mandate remains unclear and its staff and recurrent (core) budget is small (UGX 100 million; US$30,000), and with a geothermal energy development *project* budget of UGX 5.1 billion (US$1.2 million; MOFPED, 2015). This is significantly lower than for other energy resource projects such as large hydropower (UGX 92.5 billion), thermal generation capacity charges (UGX 72.3 billion) and uranium exploration (UGX 14.1 billion), and insufficient to fund a test drilling campaign. Although significant sums of development assistance are available for East African

Rift countries to support geothermal development, Uganda has had only limited success in attracting support.

The low government and development assistance spend on geothermal resources means that responsibility for its development is largely residing with the private sector. Since 2010 fourteen geothermal exploration licenses have been issued to a number of companies under the Mining Act (2003), although seemingly little activity has been ongoing, and seven have expired without renewal. Many firms appear poorly capitalised and lacking in the technical competencies needed to develop such complex and long-term projects (i.e. passive speculators), a problem not uncommon around the world (see above). Funding remains a barrier for furthering geothermal development in Uganda, in particular the need to move into a test drilling phase of development in order to test the viability of the resource.

Problematically, resource uncertainty in the Western Branch of the East African Rift System (EARS) is a major regional impediment to geothermal resource development. The only two full-size deep wells drilled in the Western EARS at Kirisimbi, Rwanda both failed to produce any evidence of a hydrothermal system. This has set back perceptions of the geothermal potential in the Western Branch of the EARS. The widely cited geothermal resource potential of Uganda stands at 450 MW, based on a regional assessment undertaken in 1982, (McNitt, 1982). Many other countries in the region have significantly revised upwards their estimates since then, however (e.g. Kenya currently estimates >10,000 MW potential compared to 1,600 MW in 1982; Tanzania recently estimated its potential at 5,000 MW compared to 650 MW by McNitt in 1982 etc.).

At least four main sites in Uganda (Kibiro, Buranga, Katwe and Payimur) and around 20 or so other prospects indicate the presence of medium- to high-enthalpy geothermal resources. Moreover, new understanding of the Western Branch of the EARS is evolving, based on comparison with analogue extensional, fault-dominated, geothermal provinces such as the Basin and Range Province of the Western United States and the Western Anatolian Extension Province in Turkey. These systems differ from the magma-dominated systems typical of the Eastern Branch of the EARS present in Kenya and Ethiopia. Both of these analogue areas are active geothermal power producers: Turkey has 13 geothermal power plants with an average capacity of 30MW and a total installed capacity of nearly 400 MW; the State of Nevada in the USA has 15 operating geothermal power plants with an average capacity of 40 MW and a total installed capacity of over 600 MW (IGA, 2014 with author updates). As such, it seems that potential exists to develop geothermal power in Western Uganda; recently the National Council for Science and Technology signed a Memorandum of Understanding (MoU) with Turkey, with geothermal power an area identified for cooperation. The Government has also signed an MoU with Kenya and Rwanda on cooperation around resource development; as such, the outlook is promising.

The backdrop outlined means that the development of a new dedicated geothermal policy is a timely intervention that could prove vital in bringing the various activities into a coordinated framework for development of the resource. It can also help increase awareness of the resource potential, especially across government, and bring about renewed interest and investment to catalyse and accelerate the pace of development of Uganda's geothermal resources.

5.2 Consultation with key stakeholders

In June and July 2016 the authors implemented an extensive stakeholder consultation exercise in order to gather views and opinions from a range of important groups, including:

1. Government ministries, agencies, and parastatals
2. Development partners and donors
3. The research and academic community
4. Private sector actors
5. Local communities in Western Uganda (Katwe and Kibiro)

A two-way roundtable format was adopted where stakeholders were introduced to geothermal energy and its characteristics, and an outline of various options for Uganda to develop policy and legal frameworks were discussed in a group format.

A summary of views expressed by stakeholders is outlined below:

- There is a need to better understand geothermal resource potential in Uganda and to accelerate its development. The government needs to take a lead, including conducting test drilling at the most promising sites;
- The mandate of the Geothermal Resources Department needs clarifying in terms of its role with respect to resource development and its regulatory functions;
- Until there is a clear project development opportunity, the government should not rush to establish a new entity responsible for geothermal development (e.g. a parastatal). The policy and legal framework needs to be flexible enough to accommodate a potential change in approach in the future upon discovery of a viable resource, however;
- There is a need to ensure the policy is developed in line with other ongoing initiatives within government in relation to energy policy development. There was broad agreement that a dedicated geothermal policy is warranted given the characteristics of the technology;
- Development partners and donors reiterated that there are a number of existing programs that may be utilized to develop geothermal resources in Uganda such as the *Geothermal Risk Mitigation Facility* (GRMF) and ongoing developments through Uganda's draft Investment Plan for *Scaled-up Renewable Energy Programme* (SREP; MEMD, 2015b). An enhanced policy and legal framework will help in progressing these funding activities.
- That private sector has a role to play in resource development. The policy and legal framework needs to promote new methods of cooperation between government and the private sector. For example, clarifying expectations regarding exploration activities by private sector actors as reflected in licensing arrangements, and more cooperation on surface studies;
- That local communities are supportive of geothermal development, but there is a need to ensure that development is sympathetic of local activities (e.g. salt production from geothermal springs) and that benefits are realised locally. Clear consideration of direct uses of geothermal heat as a catalyst for local industrial development should be included in the policy, in particular in support of agriculture and fisheries activities (e.g. food processing and drying). The scope to extract valuable minerals from geothermal brines was also highlighted as another important potential source of economic benefit to communities and the country as a whole;
- There is a need to better coordinate academic research and educational aspects of geothermal energy. Several modules exist within Ugandan University courses, but mainly in the field of mechanical engineering rather than geology. Further work is needed to bring geothermal energy into the syllabus of Earth science courses. Creation of specialised courses in the field at undergraduate level should be avoided, although scope for post-graduate studies should be explored further. Internships for students within the Geothermal Resources Department needs further effort. There was also broad agreement that geology could be better covered in the national curriculum for schools, of which geothermal should be a feature.

The experiences of geothermal energy development around the world, the different policies and legal frameworks in place, the current status of the energy sector in Uganda and the views of stakeholders all provide the basis for developing the policy and legal framework for geothermal energy in Uganda, which is ongoing at the time of writing.

6. CONCLUSIONS AND NEXT STEPS

Whilst Uganda is facing challenges for geothermal resource development, there is broad consensus amongst all stakeholders that it offers a potentially new and interesting area for power generation and industrial development. It was widely recognised that electricity from geothermal energy is clean, affordable and reliable, and can enhance energy security through diversification of the baseload power mix away from hydropower and the attendant exposure to rainfall variation, especially due to climate

change. Additionally, the direct use of geothermal energy in food processing offers a means to improve agricultural productivity and food preservation, thereby helping to enhance the nation's food security. It is also broadly recognised that, given its differences with other energy technologies, a new, dedicated, geothermal energy policy could be effective in clarifying the way in which the resources is to be developed .

The authors are currently working on the draft policy framework and legal and regulatory texts based on the analysis undertaken and inputs received from stakeholders. A round of inter-ministry/agency consultation will take place in late September 2016 on the draft documents. Thereafter it is anticipated that the texts will be held by the Minister for Energy and Minerals Development to promulgate through Uganda's parliamentary process.

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